S Before the
639.313 Montana Board of
F2bmpde Natural Resources
1991 and Conservation
V.2 in the matter of
water reservation
application nos.

BEFORE THE MONTANA BOARD OF NATURAL RESOURCES AND CONSERVATION

* *

IN THE MATTER OF WATER)
RESERVATION APPLICATION NOS.)
69903-41O 71895-41I 72578-41L)
70115-41F 71966-41S 71579-41T)
70117-41H 71997-41J 72580-41A)
70118-41H 71998-41S 72581-41I)
70119-41H 72153-41P 72582-41I)
70270-41B 72154-41K 72583-41P)
71537-41P 72155-41A 72584-41S)
71688-41L 72256-41P 72585-41M)
71889-41Q 72307-41Q 72586-41P)
71890-41K 72574-41O 72587-41G)
71891-41P 72575-41K 72588-40C)
71892-41G 72576-40E 73198-41I)
71893-41K 72577-41P 73199-41S)
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MISSOURI RIVER BASIN)

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Exhibits for prefiled direct testimony submitted in support of the Department of Fish, Wildlife and Parks' application for instream flow reservations in the upper Missouri River Basin

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November 1, 1991

Volume 2

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Volume 1

1. S. Leathe and F. Nelson, A Literature Evaluation of Montana's Wetted Perimeter Inflection Point Method for Deriving Instream Flow Recommendations (MDFWP 1986, rev. 1989).

2. F. Nelson, Guidelines for Using the Wetted Perimeter (WETP) Computer Program of the Montana Department of Fish, Wildlife and Parks (1989).

3. Photographs of Big Hole River near Twin Bridges, Montana; Graph of Wetted Perimeter/Flow Relationship for Big Hole River.

4. C. Parrett, D. Johnson and J. Hull, Estimates of Monthly Streamflow Characteristics at Selected Sites in the Upper Missouri River Basin, Montana, Base Period Water Year's 1937-86 (USGS 1989).

5. J. Elliot, The Direct and Indirect Benefits and Costs of Granting a Water Reservation for In-stream Flows in the Missouri River Basin (1989).

6. K. Knudson, The Montana Department of Fish, Wildlife and Parks' Missouri River Water Reservation Request is in the Public Interest (April 1989).

Volume 2

7. J. Duffield, J. Loomis and R. Brooks, The Net Economic Value of Fishing in Montana. Prepared for Montana Department of Fish, Wildlife and Parks, Helena, (1987).

8. J. Duffield, S. Allen and J. Holliman, Contingent Valuation of Montana Trout Fishing By River and Angler Subgroup (1988).

9. J. Duffield, et al, Instream Flows in the Missouri River Basin: A Recreation Survey and Economic Study (DNRC 1990).

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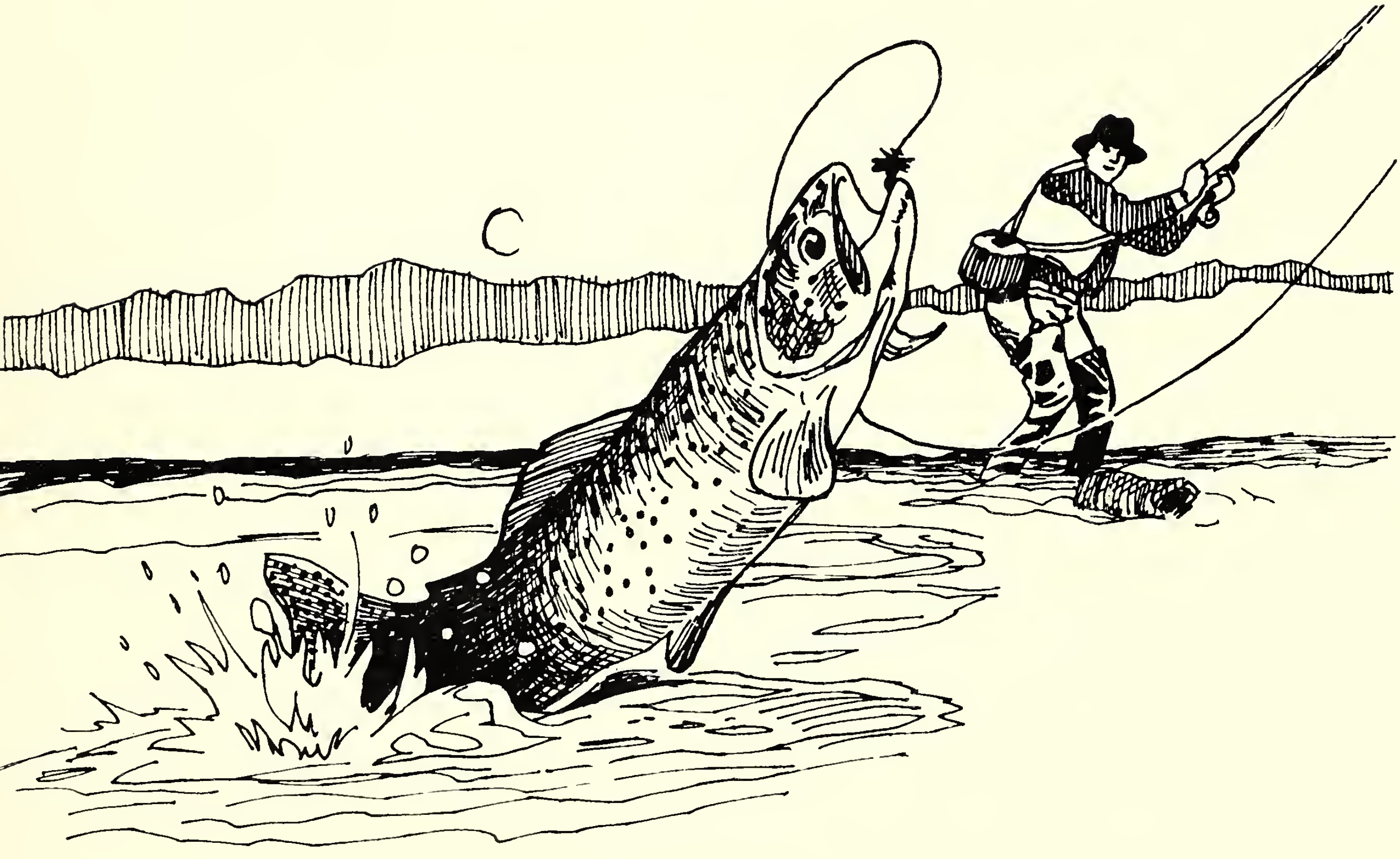
THE NET ECONOMIC VALUE OF FISHING IN MONTANA



Montana Department of Fish, Wildlife & Parks

THE NET ECONOMIC VALUE OF FISHING IN MONTANA

by

John Duffield, University of Montana
John Loomis, University of California, Davis
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Joe Holliman, University of Montana
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August, 1987

EXECUTIVE SUMMARY

The objective of this study was to estimate the net economic value (net willingness to pay) of stream and lake anglers in Montana. A regional Travel Cost Model (TCM) was used to statistically derive a demand equation from survey data collected from stream and lake anglers during the fall of 1985.

The regional TCM approach is recommended by the Water Resources Council (1979, 1983) and the U.S. Department of Interior (1986) as one of the two preferred techniques for estimating recreational benefits. In addition, a number of Federal agencies are required by the Water Resource Council and U.S. Department of Interior to use the concept of net economic value when evaluating Federal agency actions.

The TCM method uses the distance traveled as a measure of price and the number of trips taken from a given origin to a particular site as a measure of quality to trace out a demand curve for the recreation site. The resulting demand equation is used to calculate the additional amount anglers would be willing to pay, over and above their travel costs, to have the opportunity to fish at the site in question.

The state average net economic value for lake fishing is $89 per trip. For streams, the value is $113 per trip. This means an angler would be willing to pay $89 and $113 more per trip to have the opportunity to fish lakes or streams, respectively. On a per-day basis, the net economic value for lake fishing is $70 and $102 for stream fishing. Converting these values to a Forest

Service Recreation Visitor Day (RUD) yields a value of $280 for stream fishing and $342 for lake fishing. The annual aggregate value of Montana's stream and lake fishing is $122 million and $93 million, respectively. Net economic values are also derived on a site-specific basis.

Angler expenditure data collected in the same survey indicates a typical resident angler spent $48 per trip and a typical nonresident angler spent $360 per trip in Montana. Overall, a typical angler fishing in Montana spent $91.60 per trip.

The net economic values presented in this paper are the appropriate values to use in benefit/cost analysis or where economic efficiency decisions (i.e. forest or range planning) are being made. If the annual values of stream and lake fishing are put into net present value, they can be used in trade-off analysis with marketed resources such as timber, coal, or grazing. For example, the present value of the net willingness to pay values for stream fishing are conceptually comparable to stumpage prices.

TABLE OF CONTENTS

Executive Summary i

Table of Contents iii

List of Tables iv

List of Figures v

Acknowledgements vi

Introduction 1
    Purpose and Scope of Research 1
    Definition of Benefits 2

Specifics of Recreation Demand and Benefit Estimating
    Methodology 3
    Methodology 3
    Estimating First Stage or Per Capita Demand Equation 3
    Assumptions of the Travel Cost Method 4
    Calculations of Benefits from the Per Capita Demand Equation 7

Data Sources 10

Statistical Estimation of Lake Fishing Demand Equations 13
    TCM Equation Variables 13
    Lake TCM Demand Equations 14
    Site Attribute Variables 16
    Stream Variables and Data Subsets 18
    Stream TCM Demand Equations 22

Benefit Estimates 29
    Benefit Calculations and Conversion of Miles to Dollars 29
    Lake Fishing 31
    Stream Fishing 37
    Summary of Benefit Estimates 46

Angler Expenditure Data 50

References 57

Appendixes 60
    A. Survey Questionnaires
    B. Travel Cost Parameter Analysis
    C. Stream Benefit Estimates Using Predicted Trips

LIST OF TABLES

Table 1 Montana Streams, Definition of Sites 20

Table 2 Site Attribute Variables, Montana Streams 24

Table 3 Montana Streams Trip Prediction Compared to Actual 28

Table 4 Travel Cost Parameters 31

Table 5 Montana Lake Data, Net Economic Value Per Trip, Equation Without Site Attribute Data, (Standard Cost) 34

Table 6 Montana Lake Data, Net Econmic Value Per Trip, Equation Without Site Attribute Data, Equation Without Size Attribute Data, (Reported Cost) .. 35

Table 7 Montana Streams Net Economic Value Per Trip, Equation Without Site Attribute Data, (Reported Cost - Gum and Martin Approach) 39

Table 8 Montana Streams Net Economic Value Per Trip, Equation Without Site Attribute Data, (Reported Cost - Gum and Martin Approach) 40

Table 9 Montana Streams, Total Recreational Value by Site (Standard Cost - Gum and Martin Approach) 43

Table 10 Montana Streams, Total Recreational Value by Site (Reported Cost - Gum and Martin Approach) 44

Table 11 Montana Lake Data, Net Economic Value by Site (Standard Value) 47

Table 12 Montana Lake Data, Net Economic Value by Site (Reported Values) 48

Table 13 Net Economic Values Per Trip, Angler Day, and WFUD 49

Table 14 Summary, Total Average Angler Expenditure, Montana Lakes and Streams (1985 dollars) 51

Table 15 Average Angler Expenditure, Montana Complete Sample (1985 dollars) 52

Table 16 Average Angler Expenditure Per Trip, Montana Streams (1985 dollars) 53

Table 17 Average Angler Expenditures, Montana Lakes (1985 dollars) 54

LIST OF FIGURES

FIGURE 1 Travel Cost Demand Curve.......................... 9

FIGURE 2 Map of Fishing Sites.............................. 21

FIGURE 3 Second Stage TCM Demand Curve..................... 32

FIGURE 4 Gross Willingness to Pay.......................... 56

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The authors would like to thank Bob McFarland for providing us with much of the data used in this study, his excellent support of the data management effort, and for his consistent moral support on this project. We would like to thank Pat Graham for his persistence in making his vision of this study come to life. We would also like to thank Stewart Allen for his work on designing the telephone survey and for contributing his background in recreation management to this effort.

INTRODUCTION

Purpose and Scope of Research

The objective of this research is to statistically estimate the net economic value (net willingness to pay) for fishing in Montana using a survey of Montana anglers. The fishing benefit estimates are derived from a regional (multi-site) TCM demand equation. A secondary objective was to collect data on resident and nonresident angler expenditures

This study does not quantify the entire "Total Economic Value" of fisheries resources in Montana. Many people besides current anglers derive economic benefits from knowing Montana's fisheries resources and associated aquatic habitats exist (i.e. existence value) or knowing that these resources exist for future generations (i.e. bequest value). In addition, many non-current anglers would be willing to pay to maintain the opportunity to fish in Montana in the future (i.e. option value).

Research by Walsh et al. (1985) indicates that for large scale, irreversible changes (e.g. damming, dewatering, etc.) to rivers that these options, existence and bequest values, represent 80% of the total economic value of these resources. Thus, recreation reflects only about 20% of the total economic value. However, for many management actions which result in relatively small changes in fish populations or fish habitats, most of the economic effects are limited to anglers. Therefore, these angler values are of primary interest for evaluation of many land management actions associated with National Forest Plans, timber sales, and Bureau of Land Management resource management plans.

Definition of Benefits

Many Federal agencies are required by U.S. Water Resources Council Principles and Guildelines (1983) to use of net willingness to pay (e.g., net economic value) as a measure of value in Benefit Cost Analysis or evaluation of Federal actions. For example, the U.S. Forest Service uses net economic value in its FORPLAN analysis of Forest Plans. When performing natural resource damage assessments, U.S. Department of Interior regulations require calculation of economic values lost to society be measured in terms of net willingess to pay (U.S. Department of Interior, 1986). Use of net willingness to pay is also recommended in textbooks on Benefit Cost Analysis [Sassone and Schaffer, 1978; Just, Hueth and Schmitz (1982)]. Net willingness to pay reflects the direct benefits to the users and the net benefits to society. By contrast, expenditures are actually costs to the users and society but may reflect gains in local income and employment. Expenditures, when translated to local value added, is useful to evaluate local economic impacts. Expenditures are used by the U.S. Forest Service in the IMPLAN analysis of Forest Plans.

SPECIFICS OF RECREATION DEMAND AND BENEFIT ESTIMATING METHODOLOGY

Methodology

The method employed in this study is a regional Travel Cost Method. This approach is recommended by the U.S. Water Resource Council (1979, 1983) as one of the two preferred techniques for estimating recreation benefits. The method is one of the most widely applied demand estimating techniques. TCM uses observations of travel distance as a measure of price and trips taken as a measure of quantity to statistically trace out a demand equation. The resulting first stage or per capita demand equation allows the analyst to calculate the additional amount the recreationists would pay over and above their travel costs to have access to the site for fishing. This calculation is made using a "second stage" or site demand curve that relates added distance or added travel cost to visitation. See Clawson and Knetsch (1966), Dwyer, Kelly and Bowes (1977), or Sorg and Loomis (1985) for a discussion of the basic TCM approach.

Estimating First Stage or Per Capita Demand Equation

The basic per capita or first stage TCM demand equation estimated for stream and lake fishing as well as warmwater lake fishing is given in Equation 1 as:

$$(1)\ (TRIPS_{ij}/POP_i) = B0 - B1(RTDIST_{ij}) + B2(SUMTRT_j) + B3(DEMOG_i) + B4(QUAL_j) + B5(SUBS_{ik})$$

where:

$TRIPS_{ij}/POP_i$ = Angler trips per capita from county i to site j.

$RTDIST_{ij}$ = Round trip distance from angler's county of residence i to the river or lake j.

$SUMTRT_j$ = Total trout catch at river or lake j.

$DEMOG_i$ = Demographics such as income, age, years fished, etc. of anglers in county i.

$QUAL_j$ = Quality of site j as reflected in measures such as surface acres for lakes, accessibility as measured by land ownership.

$SUBS_{ik}$ = An index reflecting quality and location of substitute fishing sites k available to county i.

When implementing this basic model, we used counties as zones of origin for anglers living relatively near the site. We used groups of counties for anglers visiting at greater distances from the site to avoid recording zero visits from some intermediate distance counties. For single destination, single purpose anglers visiting from states not contiguous to Montana, we used the entire state (and its population) as a zone of origin.

Assumptions of the Travel Cost Method

Like any modeling effort, the TCM method has a few assumptions. The critical assumptions in terms of estimation of economic values are interpretation of travel cost as price paid to visit the site and statistical requirements related to cost estimating the demand function. These will each be discussed in turn.

The reasonableness of the travel cost as price assumption depends on two factors: multidestination trips and value of travel time.

With respect to the first factor, for travel cost to be considered the price paid to visit the site, such travel costs must be incurred exclusively to gain access to the recreation site. If the trip has many destinations, we cannot correctly interpret all of the travel cost as a price paid for fishing at any one particular site. To satisfy this assumption, we asked the angler if this river or lake was their primary destination. That is, would they have made the trip if fishing at this site was not available. If they said they would still make the trip, then this angler was excluded from the sample since their trip's primary purpose was to visit another site or to engage in some nonfishing activity (e.g. business). In other words, such trips did not meet the assumption of single destination trips needed to interpret travel cost as price of access to the site.

The issue of converting travel distances to a monetary price involves accounting for two costs of travel: transportation cost and opportunity cost of travel time. To convert distance to 1984 dollars, we used two measures of vehicle costs. One is the variable costs of vehicle operation from the U.S. Department of Transportation's "Cost of Owning and Operating a Vehicle-1984." This is not only a widely used source for operating costs but is recommended by the U.S. Water Resources Council (1979, 1983) for use in performing Travel Cost Method studies. However, the cost per mile obtained from this report does not reflect the higher vehicle operating costs associated with driving vehicles often used for recreation, recreational road driving conditions, etc. To account for this, we also calculated benefits using data on reported trip expenditures in our sample. This approach will be discussed in more detail later.

Since time is scarce, time spent traveling has an opportunity cost in terms of either foregone time fishing at the recreation site or foregone time spent in other activities which may be other recreation, leisure (sleeping, watching TV, reading, etc.), or working. Long travel times act as a deterrent in visiting more distant sites, even to anglers with sufficiently high income such that tranportation cost is not a factor. There is empirical evidence that travel time is viewed as costly both in the transportation planning literature (Cesario, 1976) and in sport fishing (McConnell and Strand, 1981). In the case of Rhode Island saltwater sport anglers, comparison of the deterrent effect of travel time and travel cost indicated that anglers valued the time spent traveling at about 60% of their wage rate. The value of time saved is recognized in highway benefit cost studies as well. The U.S. Water Resources Council (1979, 1983) relies on Cesario's (1976) work and suggests using a value between one-fourth and one-half the wage rate as a proxy for the opportunity cost of time. It should be noted that the wage rate is used solely as a proxy for opportunity cost of time in all other activities, and it is used even if the angler would not have been working. In this study, we used two approaches. The standard time cost estimate is based on one-third of the average wage rate for the value of travel time per the U.S. Water Resources Council, 1983. Our reported time cost value is based on our sample willingness to pay to shorten travel time. This approach will be presented in a later section.

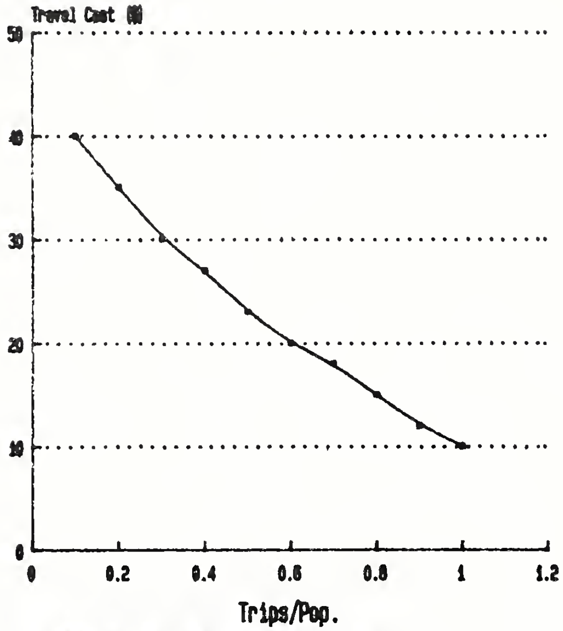
The other basic set of modeling assumptions relate to the statistical method used to estimate the travel cost per capita demand function: ordinary least squares regression. In any statistical estimation that relies on ordinary least squares regression, certain assumptions must be met for the regression (slope) coefficients to have the desired properties of best linear unbiased estimates. While most of the assumptions are met when using cross section data such as is required in TCM, one assumption is of particular concern: omitted variables. In particular, if the omitted variable is strongly correlated with the price variable, our estimates of net benefits may be over or underestimated. Two explanatory variables that one often wishes to include when performing TCM analyses are income and price-quality of substitutes. In cases where these variables were significant, they are included in the demand equations. When such variables were not significant (in the particular forms tried), they were not included in the final demand equations.

Another basic statistical assumption is that the variance of the dependent variable is constant (homoscedasticity). As discussed below, a double log specification is used here to minimize heteroscedasticity.

Calculation of Benefits from the Per Capita Demand Equation

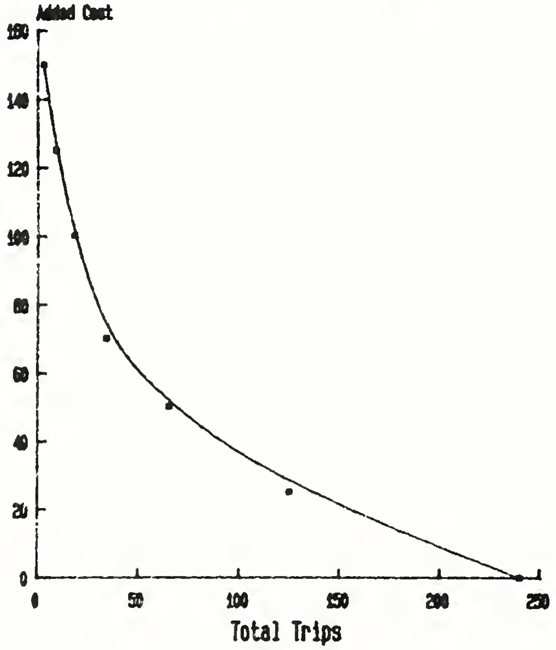
Once the per capita demand equation of the form in Equation 1 is estimated using ordinary least squares regression, benefits can be calculated in several ways. First, the per capita curve could be integrated for each zone of origin between the current distance and the maximum distance that would drive visits to less than one to calculate net willingness to pay for each zone. Site benefits would be the population's weighted sum of each zone's net willingness to pay. Alternatively, a "second stage" or site demand curve relates total site visitation to increases in distance (or travel costs) over and above the existing distance (or cost). The area under this site demand curve is net willingness to pay. This second stage demand curve approach is used in estimating lake fishing benefits since it is more amenable to programming with LOTUS 123. The first stage approach was used in estimating stream fishing benefits because of special problems created by origins very close to a given site (as will be discussed in more detail below). The equivalence of these two approaches has been demonstrated in the literature (Burt and Brewer, 1971; Menz and Wilton, 1983). Figure 1 provides an overview of the two step process illustrating the first stage and second stage TCM demand curves.

FIGURE 1
Travel Cost Method



First Stage or Per Capita Demand Curve

Second Stage or Site Demand Curve



DATA SOURCES

The data used to calculate net willingness to pay using the Travel Cost Model was collected from two separate surveys designed and administered by the Department of Fish, Wildlife and Parks. (Survey questionnaires are displayed in Appendix A).

The Fisheries Survey is designed to estimate fishing pressure on Montana's sport fishing waters. Questionnaires are mailed out monthly to 1,500 fishing license holders. During 1985, this rate was increased to 3,000 surveys per month. From May through October, 1,500 surveys were sent out every two weeks to minimize recall bias. This method of sampling provides the department with a snapshot of an angler's fishing activity during the year. Approximately 36,000 surveys were mailed to resident (92% of the sample) and nonresident (8% of the sample) fishermen. Fifty-four percent (54%) or 19,271 surveys were returned.

Of the 19,271 surveys returned, 69% (13,287) responded that they had not fished during the time period in question. The remaining 31% (5,984) said they had fished during the time period in question. They provided information on where they fished, what they caught, and what they kept along with information on the purpose of the trip, round trip distance, and whether they had stayed overnight.

The data concerning the area fished and whether it was an overnight trip was coded into ten (10) categories. These categories, in conjunction with the responses to the purpose of their trip to a particular site, determined if that particular trip was a multipurpose and/or multiple site trip. If so, this data was deleted from the file for the purposes of estimating the Travel Cost Method demand function.

In addition to the annual Fisheries Survey, a supplemental angler telephone survey was administered in September and October of 1985. This survey provided detailed socio-economic (i.e. trip expenditures, vehicle driven, travel time, income, age, etc.) data on both resident and nonresident fishermen. A sample of two thousand fishing license holders was drawn and interviewed. The respondents were initially asked if they had fished in Montana this year (1985), if the primary purpose of their most recent fishing trip was to fish and if they fished just one lake, river, or stream. Unless they answered yes to these questions, the interview was ended.

The overall response rate for the supplemental angler survey was seventy-five (75) percent. Resident fishermen comprised 80% of the sample (1,600 out of 2,000) while 20% (400) were nonresidents. Response ratio by residency was: Residents - 80% (1284 out of 1600) and Nonresidents - 52% (207 out of 400).

The lower response rate for nonresidents can be attributed to the tight screening questions since a large portion of the nonresidents were on multipurpose trips.

These two data sets were then merged in a two-step operation. Demographic data (age, income, etc.) was appended to the Fisheries Survey on an origin basis. Origins were either single or multiple counties or states. Site characteristics, i.e. fishing equipment, catch, time spent fishing, etc., were appended to the Fisheries data on a fishing site basis. Finally, travel cost and travel time information and other trip data from the supplemental survey was merged with the Fisheries data on an origin-destination basis.

STATISTICAL ESTIMATION OF FISHING DEMAND EQUATIONS

TCM Equation Variables

The basic variables shown in Equation 1 were obtained from the two surveys discussed above. However, some of the variables represent the sum of values reported by anglers. For cold and warm water fish catch, the variable represents the sum of surveyed angler catch at that specific site.

The substitute variable was constructed using both the distance variable and the sum of a site's fish catch. The substitute index measures the availability of substitute fishing sites for each county of origin. If an alternative site is regarded as more attractive than the actual site visited, then it is a potential substitute for that site. For simplicity, the attractiveness of a site is defined as that site's fish catch divided by the angler's round trip distance to that site. For each observation, if any other site's attractiveness index is greater than or equal to that of the site actually visited, then that alternate site is a substitute to the site actually visited. For each observation, the attractiveness index of all the substitute sites are summed. This summation is the substitute index. The estimated coefficient for this variable should be of a negative sign as the greater the availability (more sites that are closer) and attractiveness (greater the fish catch) of substitute fishing sites to the actual site visited in any particular observation, the lower the angler's willingness to pay is for the site actually visited would be.

Lake TCM Demand Equations

The results of the estimation of the first stage demand curve for lakes is as follows:

(2) $\ln(TRIPS_{ij}/POP_j) = 3.683 - 1.930 [\ln(RTDIST_{ij})]$

$+ 0.310 [\ln(SUMTRT_j)] + 0.108 [\ln(STWWCA)]$

$- 0.081 [\ln(SUBS_{ik})] - 0.191 [\ln(AVINCO_i)]$

$+ 0.431 [\ln(AVYRSF_i)] - 1.942 [\ln(AVED_i)]$

{t-statistics}: (-35.012)

(4.664) (3.402)

(-2.967) (-2.134)

(2.305) (-3.579)

where:

$TRIPS_{ij}$ = Lake fishing trips from origin i to site j.

POP_j = Origin i's population.

$RTDIST_{ij}$ = Round trip distance from origin i to site j.

$SUMTRT_j$ = Sum of trout catch at site j.

$STWWCA_j$ = Sum of other sport fish caught at site j, including warm water species.

$SUBSIN_{ik}$ = Substitute index reflecting the fish catch per mile at site k with higher fish catch per mile than site j.

$AVINCO_i$ = Average income of anglers in origin i.

$AVYRSF_i$ = Average years fished of anglers in origin i.

$AVED_i$ = Average education of anglers in origin i.

R^2 = 0.780, Observations = 465, F-Statistic = 231.40.

Both the R^2 and the F-Statistic are very high for a TCM demand equation. Furthermore, all the coefficients are of the expected sign (other than income and eduction) and are significant at the 95% level. The equation was estimated in the double-log form for a number of reasons. First, economic theory indicates that there is diminishing marginal value for catching additional fish. That is, each additional fish caught is worth less than the first few fish caught. One functional form consistent with diminishing marginal value is the double-log form. Interpreting Equation 2, we see that a 10% increase in trout catch results in a 3% increase in trips per capita. With the percentage increase in trips being smaller than the percentage increase in fish, the marginal value per fish will fall for increases in fish catch. Alternatively, the marginal value of a fish will rise when fish catch is reduced. The other reason for choosing a log model is that past research has shown that taking the natural log of the trips per capita minimizes two problems that arise with a linear model. First, with the log of trips per capita, the possibility of predicting negative trips per capita from distant counties that actually visited is eliminated. Second, heteroscedasticity associated with zones of different population sizes is minimized using the log of the dependent variable.

Because average income has a negative coefficient, it appears the number of lake fishing trips varies inversely with the participant's income. This negative relationship may also reflect the higher opportunity cost of time facing higher income anglers. That is, since fishing is a time intensive activity, the time costs of a fishing trip rise with income and therefore higher income anglers might take fewer trips. Lake fishing demand also appears to be inversely related to the participant's level of education.

Site Attribute Variables

In an effort to describe the recreational sites in more detail than is usual for the TCM model, the TCM equation was also estimated with the addition of several site attribute variables. In the previous case, the two fish catch variables were the only descriptors included.

Of several attribute variables tested, only two, Shore Access and Total Surface Area, were significant on the basis of one or two-tailed T-tests. Shore Access measures the level of private ownership of a site which is an indirect measure of the degree of difficulty an angler would experience in attempting to enter that site. This variable has a negative sign because it is an index measure, where the highest number (6) represents complete private ownership with no public access allowed. The smallest number (1) represents complete public access that is guaranteed due to public ownership (State or Federal) around the entire water body. The index increases in value as more of the shoreline is controlled by private ownership, making access more difficult. Therefore, demand should vary inversely with Shore Access.

Total Surface Area measures the total surface area of the water bodies included in the data set. Sites with greater surface acres provide both greater fishable waters, higher aesthetic levels, and opportunities for other recreation activities such as boating and waterskiing. Thus, we would expect the desirability of a site to anglers should be a postitive function of Total Surface Areas.

For estimation purposes, Shore Access and Total Surface Area are abbreviated as SHACC and TSA, respectively. The resulting equation is:

(3) $\ln[TRIPS_{ij}/POP_{i}) = 3.194 - 1.931\ [\ln(RTDIST_{ij})]$

{t-statistics}: (-34.820)

$+ 0.257(SUMTRT_{j})] + 0.109\ [\ln(STWWCA)]$

(3.174) (2.795)

$- 0.081\ [\ln(SUBS_{ik})] - 0.203\ [\ln(AVINCO_{i})]$

(-2.980) (-2.241)

$+ 0.462\ [\ln(AVYRSF_{i})] - 1.876\ [\ln AVED_{i}]$

(2.165) (-3.391)

$- 0.417\ [\ln(SHACC_{j})] + 0.099\ [(\ln TSA_{j})]$

(2.152) (1.506)

$R^2 = 0.780$, Observations = 449, F-Statistic = 177.36.

Again, both the R^2 and the F-Statistic are very high for a TCM demand equation. Furthermore, all the coefficients are of the expected sign (except income and education) and are significant at the 95% level. The only exception is lnTSA, which is significant at slightly less than the 90% level. This equation is also in the double-log form for the reasons discussed above.

The comparatively small changes in coefficients between

Equation 2 over Equation 3 indicate that the attribute data added only limited explanatory power. This insignificant difference indicates that the attribute variables missing from Equation 2 were not strongly correlated with the critical price coefficient. The largest change is for the coefficient on trout catch which moves from .310 to .257.

Estimated total trips for the entire sample data set was 3,870 with Equation 2 and 3,766 with Equation 3. The actual reported total trips were 3,222. Overall, this is not a poor prediction, but with an R^2 near 80% one would have hoped for a closer prediction.

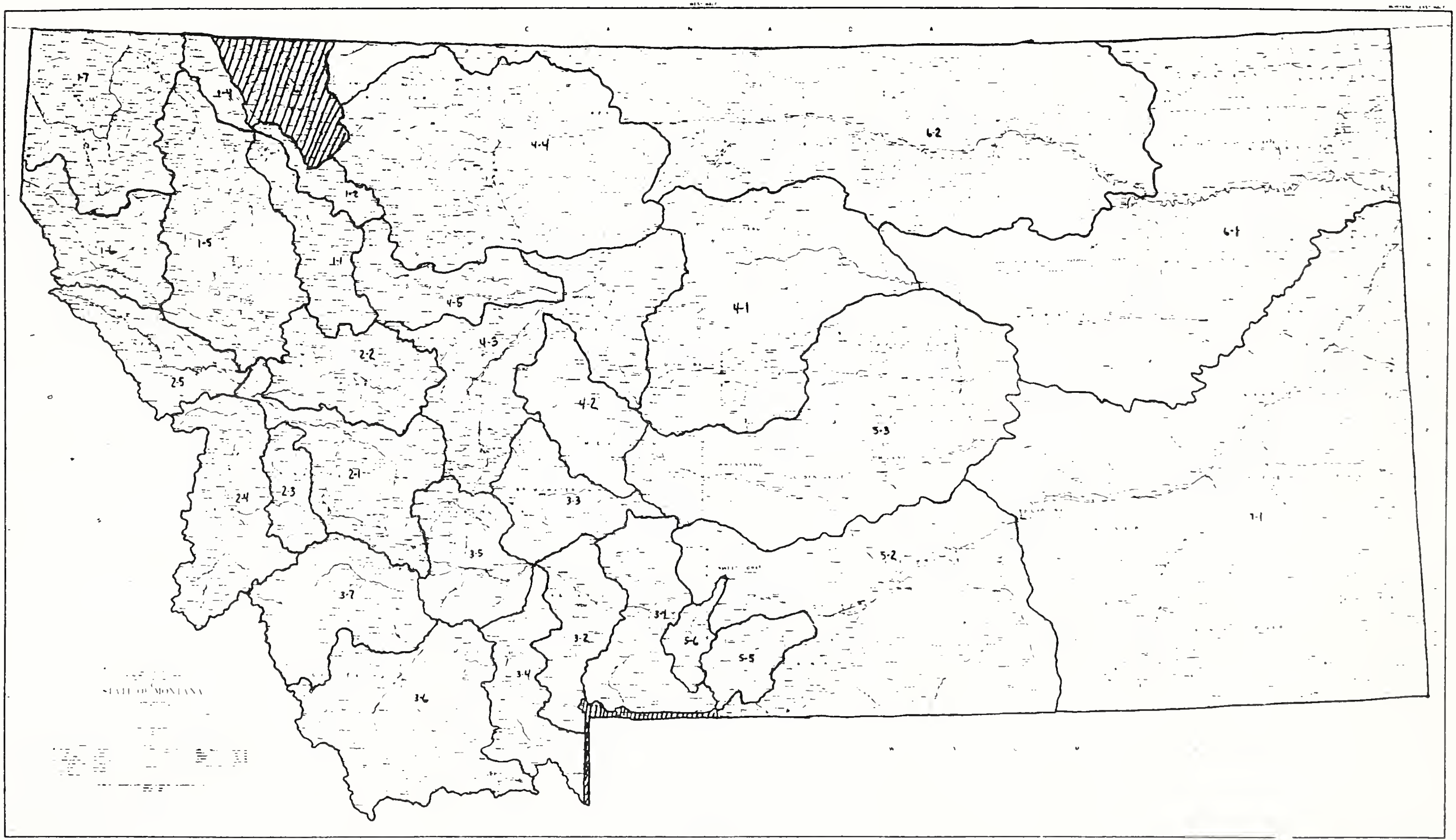
Stream Variables and Data Subsets

The stream demand equation was estimated for a set of 49 specific Montana rivers and tributaries (see Table 1 and Figure 2 below). One portion of this complete set includes the 20 "unique waters" identified by the Montana Department of Fish, Wildlife and Parks (DFWP) for the purposes of this study. These rivers are identified by a code number from 80 to 99 (Table 1). The unique waters include only major river reaches such as the Missouri between Holter and Cascade. The remaining waters included in the complete set of streams are either tributaries to the unique waters or are watersheds including both a river and its tributaries (for example, the Jefferson). The non-unique waters have codes from 11 to 71 (where the first digit corresponds to the DFWP administrative region). As an example, in the Table 1 listing, the entry Madison with code number 34 is the tributaries to the Madison River, while Madison, code 92, is the Madison River itself from the West Fork to its mouth.

The stream analysis utilized the same basic angler data sets as the lakes. Accordingly, the set of possible socio-economic, quantity, and price variables was identical. Substitute variables were also developed as described for the lake sample. However, site attribute variables were available for the stream model from two different sources: the Montana

Table 1. Montana streams, definition of sites.

RIVER CODE NO.	RIVER	DEFINITION
11	South Fork Flathead	Entire drainage
12	Middle Fork Flathead	Entire drainage
14	North Fork Flathead	Entire drainage
15	Flathead	River and tributaries below confluence with S. Fork an excluding River 89
16	Lower Clark Fork	River and tributaries below confluence with Flathead (Paradise)
17	Kootenai Tribs	Excludes mainstem River 91
21	Upper Clark Fork Tribs	Above confluence with Blackfoot (Milltown) and excluding Mainstem River 86
22	Blackfoot Tribs	Excludes Mainstem River 83
23	Rock Creek Tribs	Excludes Mainstem River 94
24	Bitterroot Tribs	Excludes Mainstem River 82
25	Middle Clark Fork Tribs	Paradise to Milltown excluding Mainstem River 87
31	Upper Yellowstone Tribs	Springdale to Gardner excluding Mainstem River 98
32	Gallatin Tribs	Excludes Mainstem River 90 and 88
33	Upper Miasouri (Region 3)	River and tributaries from Three Forks to Canyon Ferry
34	Madison Tribs	Excludes Mainstem River 92
35	Jefferson	Entire drainage
36	Beaverhead Tribs	Excludes Mainstem River 80
37	Big Hole Tribs	Excludes Mainstem River 81
41	Middle Missouri	River and tributaries below Marias River and above Fort Peck
42	Smith Tribs	Excludes Mainstem River 95
43	Upper Missouri (Region 4)	Canyon Ferry to Marias River excluding Mainstem River 93
44	Marias	Entire drainage
52	Middle Yellowstone Tribs	Springdale to confluence with Bigborn excluding River 99, 84, 85, 96, 55 and Boulder tributaries
55	Stillwater Tribs	Excludes Mainstem River 96
56	Boulder Tribs	Excludes Mainstem River 84
61	Lower Missouri	River and tributaries from upper end of Fort Peck Reservoir to N. Dakota border
62	Milk	Entire drainage
71	Lower Yellowstone	River and tributaries below Bighorn confluence
80	Beaverhead	Mainstem
81	Big Hole	Mainstem
82	Bitterroot	Mainstem to confluence of E. and W. Forks
83	Blackfoot	Mainstem
84	Boulder	Mainstem
85	Bighorn	Mainstem
86	Upper Clark Fork	Mainstem above Milltown
87	Middle Clark Fork	Mainstem Milltown to Paradise
88	East Gallatin	Mainstem
89	Upper Flathead	Mainstem above Flathead Lake to confluence of S. Fork
90	Gallatin	Mainstem
91	Kootenai	Mainstem
92	Madison	Mainstem
93	Missouri Holter-Casc	Mainstem Holter to Cascade
94	Rock Creek	Mainstem (near Missoula)
95	Smith	Mainstem
96	Stillwater	Mainstem (near Absarokee)
97	Swan	Mainstem
98	Upper Yellowstone	Mainstem Springdale to Gardner
99	Middle Yellowstone	Mainstem Springdale to confluence with Bighorn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STATE OF MONTANA

Interagency Stream Data Base and the Pacific Northwest Rivers Study. Both data bases contain detailed hydrological, physical, and biological information on a stream reach basis. This data was aggregated based on stream length-weighted averages to conform to the river sections defined for this study. It was found that for many variables information was incomplete or missing. Because the data tended to be more complete and more easily validated for the major rivers, site attribute variables were developed only for the 20 major "unique waters".

The list of eleven site attribute variables developed for the unique waters are listed in Table 2. Basically, the variables measure site specific aesthetics (scenic quality), access, and physical parameters (length, discharge, and volume). Only two of the variables, WESTHTIC (weighted aesthetic index) and WINGRESS (weighted ingress measure), are from the Interagency data base. The remainder are from Pacific Northwest Rivers Study except for DISCHARGE (flow in cubic feet per second), which was obtained from U.S. Geological Survey records and VOLUME, which is a computed variable and equals discharge times river length.

Stream TCM Demand Equations

An estimate of a double log specification of the first stage demand curve for streams is as follows:

$$
\begin{array}{llll}
(4) & \ln(\mathrm{TRIPS}_{ij}/\mathrm{POP}_i) = & -1.615 - & 1.798[\ln(\mathrm{RTDIST}_{ij}) \\
 & (\text{t-statistics}) & (-2.96) & (-50.13) \\
 & + .389[\ln(\mathrm{SUMTRT}_j)] & - 4.43[\ln(\mathrm{AVYRSF}_i) & \\
 & (7.25) & (-4.32) &
\end{array}
$$

where:

$TRIPS_{ij}$ = Stream fishing trips from origin i to site j

POP_i = Origin i's population

$RTDIST_{ij}$ = Round trip distance from i to j.

$SUMTRT_j$ = Sum of trout catch at j.

$AVYRSF_i$ = Log of average years fished of anglers in origin i.

Adjusted R^2 = .782, Observations = 727, F-Statistic = 870.0

As for the lake demand equation, the R^2 and F-Statistic are very high, indicating high explanatory power for the model. The key parameter for purposes of consumer surplus estimation is the slope coefficient on distance. This parameter is highly significant, has the expected sign, and is precisely estimated with a 95 percent confidence interval that is only plus or minus 4 percent of the estimate in Equation 4. The success variable $SUMTRT_j$ (total trout catch) and the demographic variable $AVYRSFI_i$ (trip average years fished) are also highly significant (99 percent level), but the sign on $AVYRSF_i$ is opposite of what one would expect. Two other demographic variables (average years schooling and average income) had the right sign but were significant at only about the 80 percent level. The substitute variable was not significant.

In addition to statistical significance and consistency with the theoretical model, the travel cost demand model estimate can be evaluated on how well it predicts. While the model is estimated on per capita trips, it is an accurate prediction of total trips that is critical for the consumer surplus estimate. As for the lake model, total trips are overpredicted: 8,257

TABLE 2

Site Attribute Variables

Montana Streams

variable	definition
WESTHTIC	aesthetics index (stream data base)
WINGRESS	ingress measure (stream data base)
LENGTHR	river length in miles
SNOSITER	number of recreation sites
WBTFISHR	fishable from a boat
WACCESSR	access index
WSCENICR	scenic index (river data base)
WVALUER	final value (river data base)
WROSR	ROS class
DISCHARGE	cubic feet per second average flow
VOLUME	discharge times length

against an actual of 5,214. This is an overestimate of almost 60%. Trip prediction versus actual for Equation 4 is shown in Table 3. An analysis of trip prediction on the origin-destination level indicated that just 15 of the approximately 750 origin-destination pairs (with complete information) could account for almost the entire overestimate. For these 15 cases, the actual trips were 352 while the predicted trips were 3,592. All 15 cases were for origins less than 35 miles round trip from the site and typically less than 20 miles away. In short, the log-log model overpredicts for very close sites.

A more complete analysis of residuals indicated that the model was not only overpredicting trips for nearby sites but also for very distant sites. Intermediate distances were generally underpredicted. The Glejser (1969) test for heteroscedasticity showed that residual variance was nonconstant (significantly correlated to distance). These results indicate that the double log transformation is not entirely successful at producing a model that is linear in the transformed variables.

The first stage demand function estimate for the unique waters subsample is as follows:

(5) $(TRIPS_{ij}/POP_i = -5.031 - 1.894[\ln(RTDIST_{ij})]$

(t-statistic) (-3.34) (-31.46)

$+ .484[\ln(SUMTRT_j)] - .652[\ln(AYRSF_j)]$

(6.11) (-4.24)

$$+ .412(XENGTHR_j) + .924[\ln(AVED_i)]$$

$$(2.09) \qquad\qquad (1.77)$$

Adjusted R^2 =.758, F-statistic=226.61, Observations=361.

where:

$XENGTHR_j$ = Log of river length in miles.
$AVED_i$ = Log of average years of education.

(other variables as noted previously).

The estimate for the unique waters subsample is similar to Equation 4 for the complete sample. The R^2 and F are quite high, and the variables included are all significant at the 90% level. The signs of the estimated parameters are generally consistent with the theoretical model. The only attribute variable that came in significant was river length. The coefficient on distance is again precisely estimated and is not significantly different from the corresponding estimate from the complete sample.

The major limitation of the unique waters estimate is again poor prediction of total trips. Actual for the subsample of 20 rivers is 2,874, and predicted is 5,284 or an 83% error.

The double-log estimates reported in Equations 4 and 5 are consistent with the travel cost model demand specification typically reported in the economics literature. The estimates compare favorably with published findings in terms of overall statistical significance and will be used in the benefit estimates reported below. However, because the estimates are heteroscedastic, an analysis was undertaken of alternative functional forms. This work is reported in a supplementary technical paper: "Alternative Specifications of TCM Demand Functions for Montana Cold Water Stream Fishing".

Table 3. Montana streams trip prediction compared to actual.

RIVER	RIVER CODE NO.	ORIGIN ZONES	TOTAL TRIPS	PREDICTED TRIPS
S. FORK FLATHEAD	11	4	10	14.65
MIDDLE FORK FLATHEAD	12	7	16	30.13
NORTH FORK FLATHEAD	14	10	23	14.52
FLATHEAD	15	18	90	125.18
LOWER CLARK FORK	16	20	103	111.24
KOOTENAI TRIBS	17	11	91	100.61
UPPER CLARK FORK TRIBS	21	16	106	131.14
BLACKFOOT TRIBS	22	11	39	66.14
ROCK CREEK TRIBS	23	1	6	10.16
BITTERROOT TRIBS	24	16	224	455.31
MIDDLE CLARK FORK TRIBS	25	9	36	48.85
UPPER YELLOWSTONE TRIBS	31	24	65	138.19
GALLATIN TRIBS	32	14	66	342.12
UPPER MISSOURI REGION 3	33	16	109	134.40
MADISON TRIBS	34	23	76	67.28
JEFFERSON	35	20	151	472.49
BEAVERHEAD TRIBS	36	26	100	136.68
BIG HOLE TRIBS	37	17	61	332.09
MIDDLE MISSOURI	41	18	99	159.75
SMITH TRIBS	42	6	25	142.82
UPPER MISSOURI REGION 4	43	27	278	314.45
MARIAS	44	19	82	107.60
MIDDLE YELLOWSTONE TRIBS	52	35	288	335.79
MUSSELSHELL	53	11	75	397.80
STILLWATER TRIBS	55	7	40	72.12
BOULDER TRIBS	56	7	9	16.11
LOWER MISSOURI	61	4	23	0.00
MILK	62	6	33	24.61
LOWER YELLOWSTONE	71	8	16	13.40
BEAVERHEAD	80	19	120	78.95
BIG HOLE	81	37	187	171.12
BITTERROOT	82	12	88	313.31
BLACKFOOT	83	26	149	102.78
BOULDER	84	16	57	112.76
BIGHORN	85	28	160	142.32
UPPER CLARK FORK	86	16	94	151.03
MIDDLE CLARK FORK	87	17	231	159.89
EAST GALLATIN	88	10	37	259.73
UPPER FLATHEAD	89	12	66	261.81
GALLATIN	90	31	265	231.35
KOOTENAI	91	11	121	68.35
MADISON	92	55	396	225.10
MISSOURI HOLTER-CASC	93	26	357	120.50
ROCK CREEK	94	21	89	136.53
SMITH	95	14	43	62.99
STILLWATER	96	15	133	133.75
SWAN	97	10	26	34.42
UPPER YELLOWSTONE	98	32	81	636.62
MIDDLE YELLOWSTONE	99	17	174	537.65
TOTALS			5214.00	8256.62

BENEFIT ESTIMATES

Benefit Calculations and Conversion of Miles to Dollars

As noted above, one approach to estimating site benefits is to calculate each site's second stage demand curve from the per capita demand equations. Since the price variable in the per capita demand equations is in terms of miles, the area under the second stage demand curve represents willingness to pay in additional miles. In order to calculate net economic values in dollars, the angler's additional willingness to pay in miles must be converted to willingness to pay in dollars. This involves multiplying the added distance by a cost per mile of distance. This travel cost per mile is the sum of two components, time opportunity cost per mile and variable out-of-pocket travel expenses (including vehicle operation).

As noted previously, opportunity cost of travel time reflects the deterrent effect that longer drives have on visiting more distant sites independent of the vehicle operating costs. For example, many higher income people could afford the extra $8.00 or so of gasoline costs incurred if they drove an additional two hours to fish, but many could not "afford" the additional time cost in terms of other activities foregone. Some fraction of the hourly wage is generally used as a proxy for this opportunity cost of time. This is due, in part, to work by Cesario (1976) which showed the opportunity cost of time in commuting studies equaled between one-fourth and one-half of the wage rate. In this study, two estimates of the opportunity cost of time are utilized. One estimate is based on the U.S. Water Resources Council Principles and Guidelines (1983) which suggests an opportunity cost of time at one-third of the average wage rate. For our study, this estimate is 7.0 cents per mile based on an estimated wage rate for our sample of $9.44 per hour and average sample travel speed of 45 miles per hour.

The other approach is to use our survey data on angler reported willingness to pay to shorten travel time. As developed in Appendix B, regression analysis shows that Montana anglers were willing to pay $2.06 an hour to shorten travel time or 4.6 cents per mile (at 45 miles per hour). These results suggest that the opportunity cost of time for recreational travel is one-fifth of the wage rate. This is somewhat lower than the range of opportunity costs estimated for commuter travel (one-fourth to one-half the wage rate). This is not surprising since recreational travel may be less onerous (or even enjoyable) for many people.

Variable out-of-pocket travel expenses were also figured by two different methods. The "standard" approach recommended by the Water Resources Council is based on the variable costs of operating a motor vehicle. This cost was obtained from the U.S. Department of Transportation's Cost of Owning and Operating Vehicles and Vans-1984 and is 15.2 cents per mile. This amount is based on the variable cost of operating a large-size vehicle since the latter most closely approximates engine efficiencies and size of typical vehicles utilized by anglers. The cost per passenger mile is then 5.6 cents based on our sample average of 2.76 passengers per vehicle. The reported variable travel cost is derived by regression analysis from our sample data on angler travel expenditures and equals 22.4 cents per passenger mile.

See Appendix B for more details on the calculation of reported variable travel cost.

The net result is that the standard travel cost parameter estimate (Water Resource Council Method) sums to 12.6 cents per mile and the reported parameter is 27.0 cents (Table 4 below).

Table 4. Travel cost parameters (cents per mile).

	Transportation Cost	Opportunity Cost of Time	Sum
Water Resources Council Method	5.6	7.0	12.6
Montana Sample	22.4	4.6	27.0

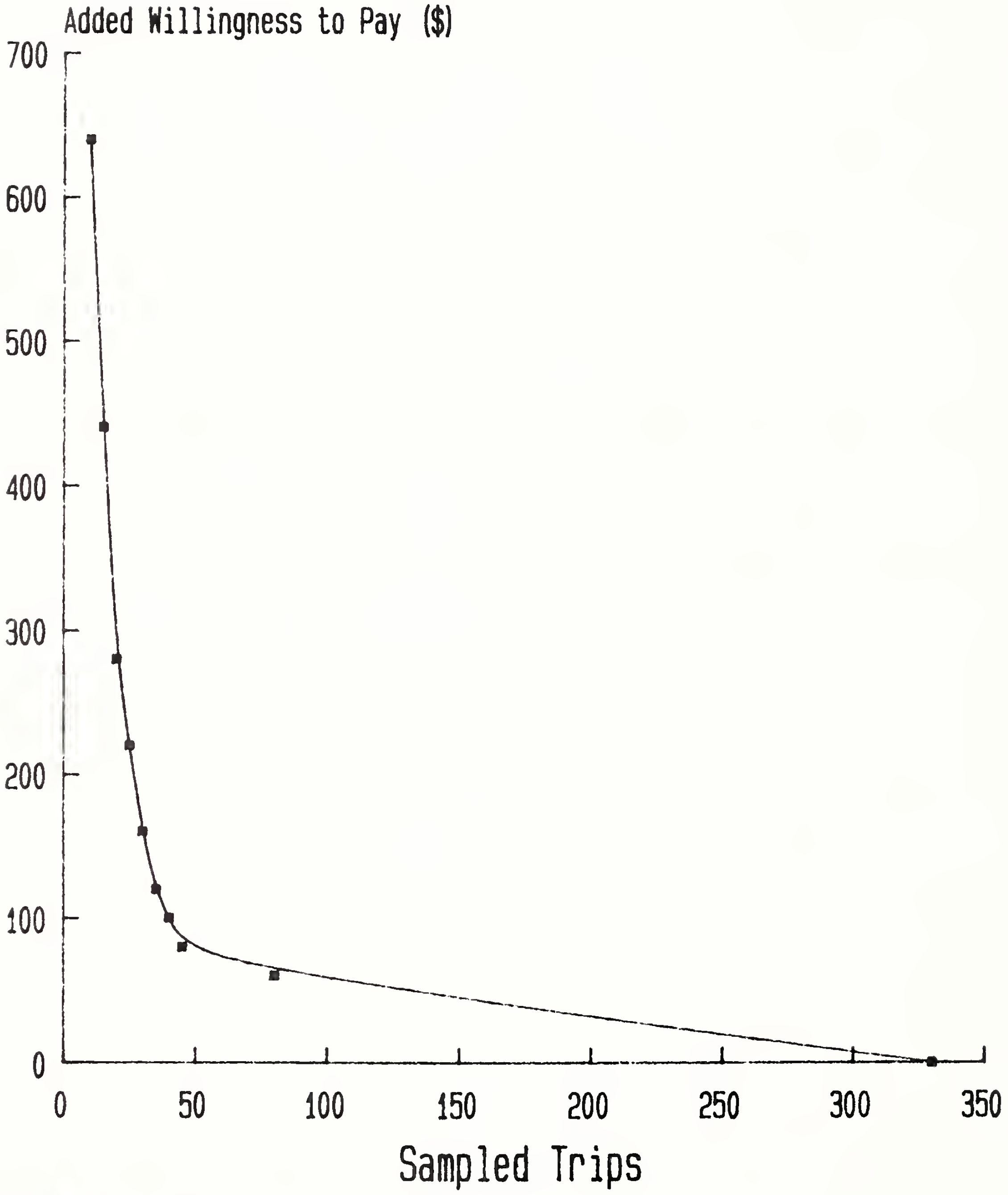
Lake Fishing

As stated earlier in this report, lake benefits are estimated based on the second stage demand curve. Specifically, the area under the second stage demand curve represents the angler's net willingness to pay, over and above the expenditure, for the opportunity to fish at this site.

To arrive at this figure, total actual trips per site must be estimated at existing travel distances. Then, additional distance is added to the existing distance in demand Equations 2 and 3 and site trips are re-estimated at this added distance. The process of adding miles to current distance is repeated to derive the site's demand schedule which shows site visitation at higher and higher fees. Such a second stage demand schedule is shown in Figure 3 for Flathead Lake.

FIGURE 3

Second Stage TCM Demand Curve



FLATHEAD LAKE SITE #1518

With the double log model, trips would never fall exactly to zero and, in some cases, the added distance where trips dropped close to zero exceeded a site's likely market area. To be conservative, we truncated the top of the second stage demand curve at the highest observed distance of all the origins visiting that specific site. The area under the resulting second stage demand curve is the net willingness to pay, or the amount the consumer is willing to pay above the actual amount paid.

Because operating cost per mile and the opportunity cost of time is measured in two different ways, consumer surplus per trip was estimated separately under each of the two alternatives. Tables 5 and 6 list net willingness to pay per trip for Equation 2 based on both the standard cost and reported cost calculations. Site average surplus per trip values are reported at the bottom of each table, equalling $88.79 per trip for the reported cost basis and $41.43 for the standard basis. Per trip values are calculated for each site as the sum of the total consumer surplus divided by the total number of estimated trips. As discussed in Loomis and Hof (1985) as well as Mumy and Hanke (1975) average consumer surplus per trip may be equal to the marginal value per trip since the public fishing sites in Montana are not price rationed.

The results discussed above are based on Equation 2. Equation 3 included additional site characteristics beyond fish catch. As one would expect given the similarity of the two equations, the benefit estimates are almost identical. For example, for reported costs the value per trip is $88.79 with Equation 2 and $87.93 with Equation 3. Accordingly, only

Table 5. Montana lake data net economic value per trip, equation without site attribute data (standard cost)

SITE #	SITE NAME	VALUE PER TRIP	AVG DAYS PER TRIP	VALUE PER DAY	NO. OF ZONES
11	S. Fork Flathead	$25.34	1.06	$23.91	8
15	Flathead Area Lakes	50.52	1.27	39.78	34
15.18	Flathead Lake	55.48	1.32	42.03	28
16	L. Clark Fork Area L.	36.92	1.46	25.29	12
17	Kootenai Area Lakes	37.09	1.26	29.44	7
17.19	Lake Koocanusa	61.84	1.38	44.81	19
21	U. Clark Fork Area L.	9.04	1.28	7.06	8
21.26	Georgetown Lake	38.98	1.18	33.03	19
22	Blackfoot Area Lakes	48.64	1.30	37.42	18
24	Bitterroot Area Lakes	32.52	1.06	30.68	6
25	L. Clark Fork Area L.	34.83	1.22	28.55	8
31.32	U. Yellow. + Gallatin	20.68	1.80	11.49	13
33	U. Missouri (Region 3)	19.37	1.38	14.04	5
33.39	Canyon Ferry Reservoir	28.77	1.37	21.00	31
34	Madison Area Lakes	90.19	1.31	68.85	18
36	Beaverhead Area Lakes	23.65	1.21	19.55	10
36.38	Clark Canyon Reservoir	90.34	1.54	58.66	26
37	Big Hole Area Lakes	48.06	1.33	36.14	12
42.48	Newlin Creek Reservoir	10.47	1.32	7.93	12
43	U. Missouri (Region 4)	5.24	1.06	4.94	11
43.46	Hauser Reservoir	15.38	1.13	13.61	13
43.47	Holter Reservoir	32.56	1.40	23.26	19
44	Marias Area Lakes	99.98	1.26	79.35	20
52	M. Yellow. + Cooney	69.23	1.25	55.38	32
53	Musselsh. + Deadman's	57.13	1.11	51.47	18
55	Stillwater Area Lakes	77.85	1.21	64.34	9
61	Lower Missouri Area L.	11.84	1.14	10.39	8
62	Milk Area Lakes	28.21	1.04	27.13	11
	SITE AVERAGE	$41.43	1.27	$32.48	

Table 6. Montana lake data net economic value per trip, equation without site attribute data (reported cost).

SITE #	SITE NAME	VALUE PER TRIP	AVG DAYS PER TRIP	VALUE PER DAY	NO. OF ZONES
11	S. Fork Flathead	$ 54.30	1.06	$ 51.23	8
15	Flathead Area Lakes	108.27	1.27	85.25	34
15.18	Flathead Lake	118.89	1.32	90.07	28
16	L. Clark Fork Area L.	79.12	1.46	54.19	12
17	Kootenai Area Lakes	79.48	1.26	63.08	7
17.19	Lake Koocanusa	132.52	1.38	96.03	19
21	U. Clark Fork Area L.	19.37	1.28	15.13	8
21.26	Georgetown Lake	83.53	1.18	70.79	19
22	Blackfoot Area Lakes	104.22	1.30	80.17	18
24	Bitterroot Area Lakes	69.69	1.06	65.75	6
25	L. Clark Fork Area L.	74.64	1.22	61.18	8
31.32	U. Yellow. + Gallatin	44.31	1.80	24.62	13
33	U. Missouri (Region 3)	41.51	1.38	30.08	5
33.39	Canyon Ferry Reservoir	61.66	1.37	45.01	31
34	Madison Area Lakes	193.26	1.31	147.53	18
36	Beaverhead Area Lakes	50.68	1.21	41.88	10
36.38	Clark Canyon Reservoir	193.59	1.54	125.71	26
37	Big Hole Area Lakes	102.99	1.33	77.44	12
42.48	Newlin Creek Reservoir	22.43	1.32	16.99	12
43	U. Missouri (Region 4)	11.22	1.06	10.58	11
43.46	Hauser Reservoir	32.96	1.13	29.17	13
43.47	Holter Reservoir	69.77	1.40	49.84	19
44	Marias Area Lakes	214.25	1.26	170.04	20
52	M. Yellow. + Cooney	148.34	1.25	118.67	32
53	Musselsh. + Deadman's	122.42	1.11	110.29	18
55	Stillwater Area Lakes	16.81	1.21	137.86	9
61	L. Missouri Area Lakes	25.37	1.14	22.25	8
62	Milk Area Lakes	60.46	1.04	58.13	11
	SITE AVERAGE	88.79	1.27	$ 69.61	

Equation 2 results are listed here.

The location of the lake fishing sites is shown in the state map displayed as Figure 2.

It is worthwhile to note that some of the lake fishing sites listed in Tables 5 and 6 are actually mixed fisheries offering both trout fishing and other sport fish including warmwater species. Based on the anglers' reported catch, we feel the following might be classified as mixed lake fisheries: Lower Clark Fork Lake fishery (#16), Blackfoot (#22), Canyon Ferry Reservoir (#33), and the Lower Missouri (#61).

The marginal value per fish trout caught and per surface acre (in Equation 3 only) can all be calculated from these equations. Marginal value per fish can be calculated by changing the value of the fish catch variable to some new higher level (if an enhancement takes place) or some lower level (if some negative impact occurs) and then predicting the new trips at current distance. By adding distance to current distance, a new second stage demand curve can be traced out under the new fishing conditions. By subtracting the original site net economic value (NEV) from the site net economic value under the changed fishing conditions, the incremental NEV (marginal value) of the change in fish conditions, the incremental NEV (marginal value) of the change in fish catch can be calculated. Such a process can be automated using LOTUS 123 MACROS, but the effort required is beyond the time and money presently available.

As can be seen from the tables, the net economic value estimates vary over a wide range. Some of the variation may be explained in terms of the site's location relative to Montana's population centers, quality of fishing, and availability of substitute sites. A detailed analysis of the variability in site values is beyond the scope of this work.

The average values reported here seem reasonable. The state average lake fishing values for standard cost are nearly identical to what Sorg et al. (1986) reported for Idaho fishing using standard cost per mile. Our net willingness to pay estimates for reported costs per mile are nearly double Idaho's. This is due in part to converting net willingness to pay in miles to dollars in Montana using a variable cost per mile that is nearly double what was used in Idaho. In Idaho, little difference was found between the reported transportation costs and standard costs. As discussed earlier, quite a difference was found between reported trip costs (including variable food and lodging costs) and standard transportation costs.

Stream Fishing

Stream fishing benefits were calculated as the area under the site demand curves, the same as for lakes. However, the specific methods differ slightly. One difference is that direct integration of the first stage demand curve was used instead of the trapezoidal approximation of the second stage demand curve. Direct integration is an exact method and was used because the numerical approximation approach was sensitive to the low origin-to-site distances found in the stream database.

The results presented for lakes are based on integrating the TCM demand curve using the predicted intercept of the demand curve with the quantity axis. The predicted intercept is the total trips predicted to be taken when the site price is zero.

For cases where the model's trip prediction is not in close agreement with the actual trips taken to a site, Gum and Martin (1975) suggest using actual trips as the starting point for benefit estimates. This approach has been widely used in the literature. Because predicted trips and actual trips differed by an average of 60% for the stream model (Table 3 above), site values based on the Gum and Martin approach are also reported here. For comparison to the lake benefit estimates, site values based on a predicted intercept are provided in Appendix C.

Stream benefit estimates for Equation 4 (complete sample) are shown in Tables 7 and 8. The average net economic value per trip across all sites is $53.08 for standard cost (.126 dollars/mile) and $113.74 for reported travel costs (.27 dollars/mile). Figure 2 provides a map of site locations. Because of small sample sizes, four stream sites were excluded from the listings in Table 1. These include the South Fork of the Flathead (Code 11), tributaries to Rock Creek (Code 23), Boulder River (Code 56), and the Lower Missouri (Code 61). These sites were excluded because results may not be reliable for sites with few origin zones and few trips per zone.

As noted, the results in Tables 7 and 8 are based on Equation 4 for the complete sample. Because Equation 5 with site attributes was very similar to Equation 4 and applied only to unique waters, only Equation 4 results are shown here. A comparison of benefit estimates from these two equations is provided in the supplementary technical report, "Sensitivity Analysis of Montana Cold Water Stream Angler Benefit Estimates".

Table 7. Montana streams net economic value per trip, equation without site attribute data (standard cost, Gum and Martin approach).

RIVER CODE	RIVER	VALUE PER TRIP	AVG DAYS PER TRIP	VALUE PER DAY	NO. OF ZONES
12	MIDDLE FORK FLATHEAD	$ 76.14	1.13	$ 67.68	7
14	NORTH FORK FLATHEAD	64.63	1.30	49.55	10
15	FLATHEAD	46.12	1.10	41.93	18
16	LOWER CLARK FORK	72.65	1.13	64.51	20
17	KOOTENAI TRIBS	36.11	1.08	33.53	11
21	UPPER CLARK FORK TRIBS	44.52	1.00	44.52	16
22	BLACKFOOT TRIBS	68.29	1.18	57.89	11
24	BITTERROOT TRIBS	34.88	1.09	31.89	16
25	MID. CLARK FORK TRIBS	38.46	1.11	34.61	9
31	U. YELLOWSTONE TRIBS	98.04	1.11	88.51	24
32	GALLATIN TRIBS	87.33	1.09	80.05	14
33	U. MISSOURI REGION 3	41.69	1.02	40.93	16
34	MADISON TRIBS	152.87	1.29	118.55	23
35	JEFFERSON	38.68	1.05	36.97	20
36	BEAVERHEAD TRIBS	78.75	1.21	65.09	26
37	BIG HOLE TRIBS	55.20	1.15	48.10	17
41	MIDDLE MISSOURI	37.06	1.02	36.33	18
42	SMITH TRIBS	7.90	1.04	7.60	6
43	U. MISSOURI REGION 4	29.77	1.04	28.64	27
44	MARIAS	33.78	1.23	27.43	19
52	MID. YELLOWSTONE TRIBS	27.25	1.07	25.40	35
53	MUSSELSHELL	29.60	1.13	26.11	11
55	STILLWATER TRIBS	38.08	1.15	33.12	7
62	MILK	10.57	1.00	10.57	6
71	LOWER YELLOWSTONE	51.59	1.00	51.59	8
80	BEAVERHEAD	52.13	1.17	44.68	19
81	BIG HOLE	76.39	1.51	50.66	37
82	BITTERROOT	33.88	1.05	32.41	12
83	BLACKFOOT	66.18	1.01	65.30	26
84	BOULDER	83.93	1.33	62.95	16
85	BIGHORN	56.45	1.29	43.84	28
86	UPPER CLARK FORK	24.23	1.01	23.97	16
87	MIDDLE CLARK FORK	31.71	1.05	30.27	17
88	EAST GALLATIN	68.44	1.03	66.64	10
89	UPPER FLATHEAD	26.35	1.02	25.96	12
90	GALLATIN	75.32	1.06	71.03	31
91	KOOTENAI	26.29	1.02	25.86	11
92	MADISON	109.32	1.45	75.16	55
93	MISSOURI HOLTER-CASC	27.96	1.19	23.49	26
94	ROCK CREEK	80.58	1.30	61.82	21
95	SMITH	43.77	1.33	33.02	14
96	STILLWATER	38.29	1.21	31.63	15
97	SWAN	30.52	1.08	28.34	10
98	UPPER YELLOWSTONE	107.50	1.10	97.84	32
99	MIDDLE YELLOWSTONE	29.35	1.01	29.18	17
	SITE AVERAGES	$ 53.08	1.13	$ 46.11	

Table 8. Montana streams net economic value per trip, equation without site attribute data (reported cost, Gum and Martin approach).

RIVER CODE NO.	RIVER	VALUE PER TRIP	AVG DAYS PER TRIP	VALUE PER DAY	NO. OF ZONES
12	MIDDLE FORK FLATHEAD	163.15	1.13	145.03	7
14	NORTH FORK FLATHEAD	138.50	1.30	106.18	10
15	FLATHEAD	98.84	1.10	89.85	18
16	LOWER CLARK FORK	155.68	1.13	138.24	20
17	KOOTENAI TRIBS	77.37	1.08	71.84	11
21	UPPER CLARK FORK TRIBS	95.40	1.00	95.40	16
22	BLACKFOOT TRIBS	146.35	1.18	124.06	11
24	BITTERROOT TRIBS	74.74	1.09	68.34	16
25	MID. CLARK FORK TRIBS	82.42	1.11	74.17	9
31	U. YELLOWSTONE TRIBS	210.08	1.11	189.66	24
32	GALLATIN TRIBS	187.13	1.09	171.54	14
33	U. MISSOURI REGION 3	89.33	1.02	87.72	16
34	MADISON TRIBS	327.57	1.29	254.04	23
35	JEFFERSON	82.89	1.05	79.21	20
36	BEAVERHEAD TRIBS	168.76	1.21	139.47	26
37	BIG HOLE TRIBS	118.28	1.15	103.07	17
41	MIDDLE MISSOURI	79.41	1.02	77.84	18
42	SMITH TRIBS	16.94	1.04	16.29	6
43	U. MISSOURI REGION 4	63.79	1.04	61.36	27
44	MARIAS	72.39	1.23	58.77	19
52	MID. YELLOWSTONE TRIBS	58.39	1.07	54.42	35
53	MUSSELSHELL	63.42	1.13	55.96	11
55	STILLWATER TRIBS	81.61	1.15	70.97	7
62	MILK	22.64	1.00	22.64	6
71	LOWER YELLOWSTONE	110.56	1.00	110.56	8
80	BEAVERHEAD	111.70	1.17	95.75	19
81	BIG HOLE	163.70	1.51	108.55	37
82	BITTERROOT	72.60	1.05	69.45	12
83	BLACKFOOT	141.81	1.01	139.94	26
84	BOULDER	179.84	1.33	134.88	16
85	BIGHORN	120.95	1.29	93.94	28
86	UPPER CLARK FORK	51.92	1.01	51.37	16
87	MIDDLE CLARK FORK	67.96	1.05	64.87	17
88	EAST GALLATIN	146.66	1.03	142.80	10
89	UPPER FLATHEAD	56.46	1.02	55.62	12
90	GALLATIN	161.41	1.06	152.22	31
91	KOOTENAI	56.33	1.02	55.41	11
92	MADISON	234.26	1.45	161.06	55
93	MISSOURI HOLTER-CASC	59.92	1.19	50.33	26
94	ROCK CREEK	172.66	1.30	132.47	21
95	SMITH	93.80	1.33	70.76	14
96	STILLWATER	82.05	1.21	67.78	15
97	SWAN	65.39	1.08	60.72	10
98	UPPER YELLOWSTONE	230.35	1.10	209.65	32
99	MIDDLE YELLOWSTONE	62.80	1.01	62.53	17
	SITE AVERAGES	**$113.74**	**1.13**	**$ 98.82**	

The values per trip shown in Tables 7 and 8 vary considerably across sites. In general, the relative values seem plausible. Some of the highest valued trips are on the Madison and its tributaries, Rock Creek, the Big Hole, and the Upper Yellowstone. The lowest valued waters include the Milk, Musselshell, Upper Clark Fork, Kootenai, and Flathead.

Relative values, of course, Reflect both quality and location. The site specific travel cost model (TCM) values for streams (Tables 7 and 8) have been compared with site level values based on a companion contingent valuation method (CVM) study (Duffield and Allen, 1987). The comparative analysis is summarized in the latter report. In general, the results indicate consistency between the TCM and CVM methods. TCM estimates based on the Gum and Martin method and reported costs are most similar to the CVM site level values. The similarity of results from the two very different methodologies provides a measure of validation for both models.

Tables 7 and 8 also show net values per day. The average over all sites is $46.11 per day (standard basis) and $98.82 per day (reported cost basis). The (angler days) values per day were multiplied by angler pressure estimates for 1985-86 to calculate the fishing-related recreational value of the specific sites.

The angler pressure estimates were obtained from Bob McFarland of the Montana Department of Fish, Wildlife and Parks. The estimates are for the license season of 1 March to the end of February. Total fishing pressure on all trout streams in the state is estimated to be 1,221,331 for 1985-1986.

Our sample of streams excludes approximately 2% of the total state pressure (28,673 angler days). The specific sites excluded from our sample due to limited use and observations are: Sun River, St. Mary's River, South Fork of the Flathead, Lower Missouri, tributaries to the Boulder and Rock Creek, and the following river sections: Milk River (Region 4 only), Clark Fork (Region 3 only), and Musselshell (Region 4 only).

The state total values are $57 million and $122 million for standard and reported cost basis respectively (Tables 9 and 10). Since 1985 was a drought year, these estimates may be a conservative estimate of site values for a normal or average water year.

It should also be noted that these are annual values; the corresponding present values of these annual streams depend on the interest rate, the assumed rate of change in the annual values over time and the time horizon. For example, assuming no growth, an infinite time horizon and a four percent real discount rate, the present angling-related recreational value of Montana's trout streams is between $1.5 and $3.1 billion. This estimate would roughly correspond to the market value of these waters as a recreational asset.

Since Montana's stream fisheries are a renewable (non-stocked) resource, the assumption of an infinite horizon is appropriate. To the extent that there is increased fishing pressure over time, the assumption of no growth provides a conservative bias in addition to the effect of using a drought year as a base. Lower discount rates would, of course, result in higher present values and conversely higher rates. The Northwest

Table 9. Montana streams, total recreation value by site (Standard cost, Gum and Martin approach).

RIVER CODE	RIVER	VALUE PER DAY	FISHING PRESSURE	SITE VALUE ($1000)
12	MIDDLE FORK FLATHEAD	$ 67.68	5851	$ 396
14	NORTH FORK FLATHEAD	49.55	8037	398
15	FLATHEAD	41.93	35545	1490
16	LOWER CLARK FORK	64.51	21237	1370
17	KOOTENAI TRIBS	33.53	26081	874
21	UPPER CLARK FORK TRIBS	44.52	24207	1078
22	BLACKFOOT TRIBS	57.89	9075	525
24	BITTERROOT TRIBS	31.89	33676	1074
25	MIDDLE CLARK FORK TRIBS	34.61	6835	237
31	UPPER YELLOWSTONE TRIBS	88.51	12424	1100
32	GALLATIN TRIBS	80.05	14045	1124
33	UPPER MISSOURI REGION 3	40.93	25419	1041
34	MADISON TRIBS	118.55	11224	1331
35	JEFFERSON	36.97	29129	1077
36	BEAVERHEAD TRIBS	65.09	25878	1684
37	BIG HOLE TRIBS	48.10	18624	896
41	MIDDLE MISSOURI	36.33	22340	812
42	SMITH TRIBS	7.60	7143	54
43	UPPER MISSOURI REGION 4	28.64	67557	1935
44	MARIAS	27.43	5925	162
52	MIDDLE YELLOWSTONE TRIBS	25.40	30132	765
53	MUSSELSHELL	26.11	11218	293
55	STILLWATER TRIBS	33.12	13002	431
62	MILK	10.57	5965	63
71	LOWER YELLOWSTONE	51.59	995	51
80	BEAVERHEAD	44.68	24239	1083
81	BIG HOLE	50.66	47910	2427
82	BITTERROOT	32.41	56024	1816
83	BLACKFOOT	65.30	28794	1880
84	BOULDER	62.95	17429	1097
85	BIGHORN	43.84	44814	1965
86	UPPER CLARK FORK	23.97	17578	421
87	MIDDLE CLARK FORK	30.27	30414	921
88	EAST GALLATIN	66.64	6191	413
89	UPPER FLATHEAD	25.96	15262	396
90	GALLATIN	71.03	63871	4537
91	KOOTENAI	25.86	22591	584
92	MADISON	75.16	108712	8171
93	MISSOURI HOLTER-CASC	23.49	72788	1710
94	ROCK CREEK	61.82	27881	1724
95	SMITH	33.02	11824	390
96	STILLWATER	31.63	32857	1039
97	SWAN	28.34	8746	248
98	UPPER YELLOWSTONE	97.84	52016	5089
99	MIDDLE YELLOWSTONE	29.18	31156	909
	STATE TOTAL		**1192658**	**$57081**

Table 10. Montana streams, total recreational value by site (reported cost, Gum and Martin approach).

RIVER CODE	RIVER	VALUE PER DAY	FISHING PRESSURE	SITE VALUE ($1000)
12	MIDDLE FORK FLATHEAD	$145.03	5851	$ 849
14	NORTH FORK FLATHEAD	106.18	8037	853
15	FLATHEAD	89.85	35545	3194
16	LOWER CLARK FORK	138.24	21237	2936
17	KOOTENAI TRIBS	71.84	26081	1874
21	UPPER CLARK FORK TRIBS	95.40	24207	2309
22	BLACKFOOT TRIBS	124.06	9075	1126
24	BITTERROOT TRIBS	68.34	33676	2301
25	MIDDLE CLARK FORK TRIBS	74.17	6835	507
31	UPPER YELLOWSTONE TRIBS	189.66	12424	2356
32	GALLATIN TRIBS	171.54	14045	2409
33	UPPER MISSOURI REGION 3	87.72	25419	2230
34	MADISON TRIBS	254.04	11224	2851
35	JEFFERSON	79.21	29129	2307
36	BEAVERHEAD TRIBS	139.47	25878	3609
37	BIG HOLE TRIBS	103.07	18621	1919
41	MIDDLE MISSOURI	77.84	22340	1739
42	SMITH TRIBS	16.29	7143	116
43	UPPER MISSOURI REGION 4	61.36	67557	4146
44	MARIAS	58.77	5925	348
52	MIDDLE YELLOWSTONE TRIBS	54.42	30132	1640
53	MUSSELSHELL	55.96	11218	628
55	STILLWATER TRIBS	70.97	13002	923
62	MILK	22.64	5965	135
71	LOWER YELLOWSTONE	110.56	995	110
80	BEAVERHEAD	95.75	24239	2321
81	BIG HOLE	108.55	47910	5201
82	BITTERROOT	69.45	56024	3891
83	BLACKFOOT	139.94	28794	4029
84	BOULDER	134.88	17429	2351
85	BIGHORN	93.94	44814	4210
86	UPPER CLARK FORK	51.37	17578	903
87	MIDDLE CLARK FORK	64.87	30414	1973
88	EAST GALLATIN	142.80	6191	884
89	UPPER FLATHEAD	55.62	15262	849
90	GALLATIN	152.22	63871	9722
91	KOOTENAI	55.41	22591	1252
92	MADISON	161.06	108712	17509
93	MISSOURI HOLTER-CASC	50.33	72788	3664
94	ROCK CREEK	132.47	27881	3693
95	SMITH	70.96	11824	837
96	STILLWATER	67.78	32857	2227
97	SWAN	60.72	8746	531
98	UPPER YELLOWSTONE	209.65	52016	10905
99	MIDDLE YELLOWSTONE	62.53	31156	1948
	STATE TOTAL		1192658	$122315

Power Planning Council, for example, has used a 3 percent real discount rate in its economic analysis of energy resources. It is beyond the scope of this study to identify the appropriate rate for the purposes at hand. However, by comparison with the rate used by the Northwest Power Planning Council, the rate used here further ensures that the present value estimates are a defensible lower bound for policy purposes. In fact, site values may be considerably higher.

The relative comparison of sites in terms of annual site values is of interest. The mainstem Madison has the heaviest pressure of any stream in the state (108,712 angler days/year) and also has one of the highest per day value. As a result, the Madison is the most valuable stream in the state with a value that is approximately twice that of any of the next most valuable waters (Upper Yellowstone, Gallatin, and Big Hole).

A statewide average net economic value per fishing day can be derived from Tables 9 and 10 by dividing total site value by total angler days. The result is $102.56 and $47.86 per day, respectively, for the reported and standard cost basis. Because fishing pressure tends on average to be greater on the higher valued streams, the overall state averges are somewhat higher than corresponding single (not weighted by use) site averages reported in Tables 7 and 8 ($98.82 and $46.11 respectively). Use-weighted state average values per fishing trip are $117.65 and $54.90 (reported and standard basis) based on the stream sample average days fished per trip (1.1471).

Tables 5 and 6 also show values per day of lake fishing based on the average day per trip by site. The site averages are

$69.61 and $32.48 per day per trip for the reported and standard cost basis. The per day values are multiplied times the estimated annual fishing pressure (angler days) to derive the site net economic values associated with lake fishing use. The state total for Montana lake fishing sites is $43 million and $93 million respectively for the standard and reported cost basis (Tables 11 and 12). These are annual values. The present value of these sites assuming no growth in use or value and a four percent real discount rate is around $1.1 to $2.3 billion dollars.

Summary of Benefit Estimates

Table 13 presents the values per trip, angler day, and 12 hour Wildlife and Fish User Day (WFUD) used by the U.S. Forest Service. The lake fishing values per day are $69.61 (reported cost basis). To calculate a 12 hour WFUD, the lake fishing sample average of 2.44 hours of fishing per day was used. Thus, the $342.34 per WFUD (reported cost basis of .126 dollars/mile) represents about 5 angler days given the relatively short amount of each day actually spent fishing. The reported stream fishing value per day is $102.56. Based on the stream fishing sample, anglers fished 4.39 hours per day. This implies a reported cost basis stream fishing WFUD of $280.35 Table 13 also provides a summary of values where travel costs are at their standard value of 12.6 dollars per mile.

Table 11. Montana coldwater lake data -- net economic value by site -- standard values

SITE #	SITE NAME	VALUE PER DAY	TOTAL RECREATIONAL FISHING VALUE
11	S. FORK FLATHEAD	$23.91	$304,709
15	FLATHEAD AREA LAKES	39.78	4,665,876
15.18	FLATHEAD LAKE	42.03	3,192,767
16	L. CLARK FORK AREA L.	25.29	567,002
17	KOOTENAI AREA LAKES	29.44	632,253
17.19	L. KOOCANUSA	44.81	5,118,601
21	U. CLARK FORK AREA L.	7.06	60,714
21.26	GEROGETOWN LAKE	33.03	1,408,994
22	BLACKFOOT AREA LAKES	37.42	1,591,122
24	BITTERROOT AREA LAKES	30.68	249,181
25	L. CLARK FORK AREA L.	28.55	150,041
31.32	U. YELLOW. + GALLATIN	11.49	392,234
33	U. MISSOURI (REGION 3)	14.04	58,579
33.39	CANYON FERRY RESERVOIR	21.00	1,596,735
34	MADISON AREA LAKES	68.85	2,846,514
36	BEAVERHEAD AREA LAKES	19.55	252,121
36.38	CLARK CANYON RESERVOIR	58.66	2,105,894
37	BIG HOLE AREA LAKES	36.14	493,484
42.48	NEWLIN CREEK RESERVOIR	7.93	73,305
43	U. MISSOURI (REGION 4)	4.94	65,991
43.46	HAUSER RESERVOIR	13.61	315,480
43.47	HOLTER RESERVOIR	23.36	1,768,329
44	MARIAS AREA LAKES	79.35	8,448,863
52	M. YELLOW. + COONEY	55.38	4,085,795
53	MUSSELSHELL + DEADMAN'S	51.47	786,070
55	STILLWATER AREA LAKES	64.34	355,257
61	LOWER MISSOURI AREA L.	10.39	235,466
62	MILK AREA LAKES	27.13	1,434,628
	STATE TOTAL		**$43,256,004**

Table 12. Montana coldwater lake data -- net economic value by site -- reported values

SITE #	SITE NAME	VALUE PER DAY	TOTAL RECREATIONAL FISHING VALUE
11	S. FORK FLATHEAD	$51.23	$652,829
15	FLATHEAD AREA LAKES	85.25	9,999,374
15.18	FLATHEAD LAKE	90.07	6,841,939
16	L. CLARK FORK AREA L.	54.19	1,214,980
17	KOOTENAI AREA LAKES	63.08	1,354,692
17.19	L. KOOCANUSA	96.03	10,969,295
21	U. CLARK FORK AREA L.	15.13	130,137
21.26	GEORGETOWN LAKE	70.79	3,019,680
22	BLACKFOOT AREA LAKES	80.17	3,408,847
24	BITTERROOT AREA LAKES	65.75	533,978
25	L. CLARK FORK AREA L.	61.18	321,525
31.32	U. YELLOW. + GALLATIN	24.62	840,339
33	U. MISSOURI (REGION 3)	30.08	125,502
33.39	CANYON FERRY RESERVOIR	45.01	3,422,130
34	MADISON AREA LAKES	147.53	6,099,300
36	BEAVERHEAD AREA LAKES	41.88	540,148
36.38	CLARK CANYON RESERVOIR	125.71	4,512,910
37	BIG HOLE AREA LAKES	77.44	1,057,374
42.48	NEWLIN CREEK RESERVOIR	16.99	157,078
43	U. MISSOURI (REGION 4)	10.58	141,400
43.46	HAUSER RESERVOIR	29.17	676,118
43.47	HOLTER RESERVOIR	49.84	3,772,514
44	MARIAS AREA LAKES	170.04	18,105,128
52	M. YELLOW. + COONEY	118.67	8,755,316
53	MUSSELSH. + DEADMAN'S	110.29	1,684,367
55	STILLWATER AREA LAKES	137.86	761,200
61	L. MISSOURI AREA L.	22.25	504,346
62	MILK AREA LAKES	58.13	3,074,144
	STATE TOTAL		$92,676,590

Table 13. Net economic values per trip, angler day, and WFUD[5] for Montana lake and stream fishing

A. BASED ON STANDARD COST OF .126 DOLLARS/MILE

ACTIVITY	VALUE PER TRIP	VALUE PER DAY	VALUE PER WFUD[5]
lake fishing[1]	$41.43	$32.48	$159.74
stream fishing[2]	54.90[3]	47.86	130.82[4]
combination	48.61	40.68	144.32

B. BASED ON REPORTED COST OF .27 DOLLARS/MILE

ACTIVITY	VALUE PER TRIP	VALUE PER DAY	VALUE PER WFUD
lake fishing[1]	$88.79	$69.61	$342.34
stream fishing[2]	117.65[3]	102.56	280.35[4]
combination	104.18	87.18	309.28

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[1] Site average

[2] State fishing pressure weighted average

[3] Derived from value per day using stream sample average of 1.1471 days/trip

[4] Derived from value per day using stream sample average of 4.39 hours of fishing per day

[5] WFUD is a 12 hour wildlife and fish user day utilized by the U.S. Forest Service

ANGLER EXPENDITURE DATA

The values reported above for stream and lakes are net economic values associated with fishing recreational use. This is the estimated value that users derive over and above trip costs.

Another measure of the economic significance of lake and stream fishing in Montana is angler expenditures. Average expenditure per fishing trip in Montana is $91.59 (Table 14) based on our sample of 1,343 individual anglers.

This total does not vary greatly between lakes and streams, at $91.90 and $96.74 respectively. However, there are significant differences between residents and nonresidents. The state average is $48.13 and $360.24 dollars per trip for residents and nonresidents, respectively (Table 14). The greatest difference is for the stream subsample where nonresidents outspend residents by a ratio of 15:1 ($536 versus $36). Table 14 also reports expenditure per day fished. This averages $42.21 and ranges from $22.13 per day for resident stream anglers to $116.37 for nonresident stream anglers.

More detailed expenditure information in Tables 15, 16, and 17, shows that the major expenditures are on transportation, lodging, and food. Round trip travel distance is also shown. The average fishing trip in Montana is 258 miles round trip. However, the average resident travels only 119 miles to fish Montana streams while the nonresident stream fisherman travels on the average of 1,521 miles per trip. Obviously, expenditures and distance traveled are closely correlated (as is developed in some detail in Appendix B).

Table 14. Summary -- total average angler expenditure -- Montana lakes and streams -- 1985 dollars

CATEGORY	ALL	RESIDENTS	NONRESIDENTS
TOTAL AVERAGE EXPENDITURE PER TRIP:			
LAKES	91.90	62.54	249.05
STREAMS	96.74	36.15	536.47
ALL WATERS	91.59	48.13	360.24
TOTAL AVERAGE EXPENDITURE PER DAY[a]:			
LAKES	37.98	31.91	50.31
STREAM	47.89	22.31	116.37
ALL WATERS	42.21[b]	26.89	75.05

SAMPLE SIZE: LAKES (648), STREAMS (611), ALL WATERS (1343).

[a] Average per day fished.

[b] Overall weighted average of 2.17 angler days per trip for both stream and lake.
Overall weighted average of 3.48 hours per day for both stream and lake.

Table 15. Average angler expenditure per day -- Montana complete sample -- 1985 dollars

ITEM	MEAN ALL	 RESIDENT	 NONRESIDENT
TRANSPORTATION	28.24	15.73	105.58
LODGING FEES	13.06	4.70	64.70
FOOD - RESTAURANTS	13.08	5.22	61.65
FOOD - STORES	25.18	16.50	78.85
TACKLE	6.55	3.24	27.02
GUIDE	1.63	1.04	5.28
OTHER	3.86	1.71	17.16
TOTAL	**91.59**	**48.13**	**360.24**
ROUND TRIP DISTANCE (MILES)	258	139	992
SAMPLE SIZE	1,343	1,156	187

Table 16. Average angler expenditure per trip, Montana Stream (1985 dollars).

	MEAN		
ITEM	ALL	RESIDENT	NONRESIDENT
TRANSPORTATION	31.64	13.05	166.51
LODGING FEES	14.66	1.13	112.81
FOOD-RESTAURANT	15.84	4.92	95.10
FOOD-STORES	19.68	11.31	80.39
TACKLE	8.23	2.72	48.23
GUIDE	3.47	2.20	12.66
OTHER	3.24	.82	20.77
TOTAL	**96.74**	**36.15**	**536.47**

ROUND TRIP DISTANCE (MILES)	289	119	1521
SAMPLE SIZE	611	537	74

Table 17. Average angler expenditure per trip, Montana lakes (1985 dollars).

ITEM	MEAN		
	ALL	RESIDENTS	NONRESIDENTS
TRANSPORTATION	26.85	19.09	68.40
LODGING FEES	12.36	8.69	31.97
FOOD-RESTAURANT	10.90	5.84	37.97
FOOD-STORES	31.82	22.40	82.22
TACKLE	5.13	3.72	12.65
GUIDE	.04	.05	.00
OTHER	4.81	2.75	15.84
TOTAL	**91.90**	**62.54**	**249.05**
ROUND TRIP DISTANCE (MILES)	241	167	640
SAMPLE SIZE	648	546	102

When expenditures and net economic values are added together, the sum is termed "gross willingness to pay" (WTP). This measures the gross total value associated with the activity. The latter may correspond roughly to the market price for a package fishing trip including all expenses. Gross values are not appropriate for valuing a site since they include the costs associated with many other services and assets utilized on a given trip such as gasoline and food.

On a reported cost basis, the average gross WTP associated with lake fishing in Montana is average expenditure per trip ($91.90) plus net economic value per trip ($88.79)[1] or $180.69 Similarly, for streams gross WTP is $214.39 or expenditure of $96.74 plus an average net value of $117.65. These values are shown in Figure 4.

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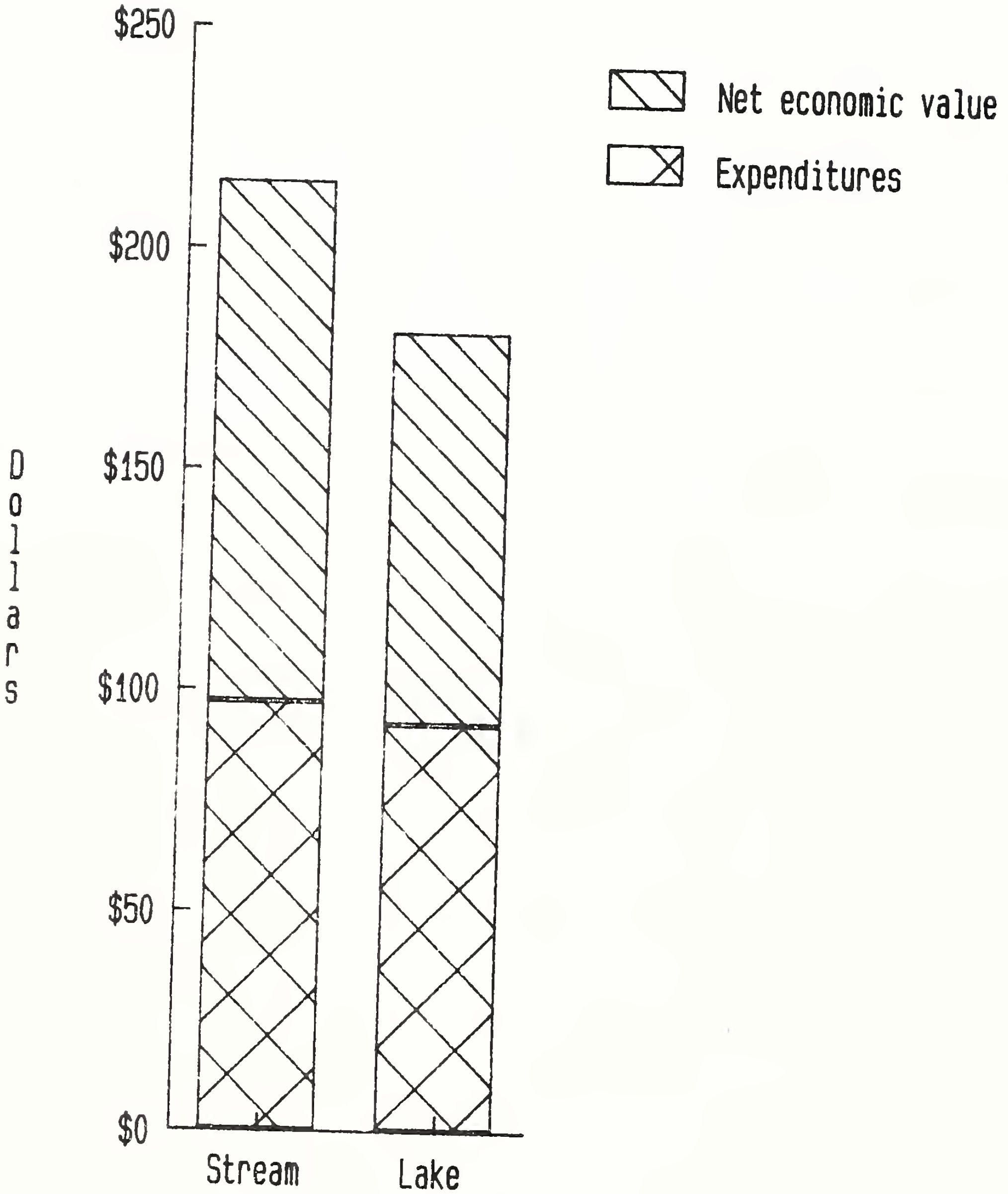
[1] This is a site average.

FIGURE 4

Gross Willingness to Pay

Montana Stram and Lake Fishing



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APPENDIX A

Survey Questionnaires.

ANGLER PHONE SURVEY

PLACE LABEL HERE

Interview date:__________

Interviewer name:__________________

1) DID YOU FISH IN MONTANA THIS SEASON? (3/85 - 2/86) YES=1 NO=2 |____| 1

2) I'D LIKE TO ASK SOME QUESTIONS ABOUT YOUR MOST RECENT FISHING TRIP IN MONTANA - SPECIFICALLY, THE LAST TRIP FOR WHICH FISHING WAS THE MAIN OR ONLY REASON YOU TOOK THE TRIP, AND WHERE YOU WERE PRIMARILY FISHING ONE LAKE, RIVER, OR STREAM.

If interview is ended here because fishing was NOT main reason or trip was multiple destination, write down reason and names of multiple destinations.

Code: |___|___|-|___|___|___|___| 2 3 4 5 6 7

NAME OF LAKE/STREAM:______________ ☐ ✓ If Special Regulation Stream

CLOSEST TOWN:______________

REASON:______________

DESTINATIONS:______________

3) WHEN DID YOU MAKE THIS TRIP TO_______? DATE: |___|___|/|___|___|/|___|___| (mo. 8 9, day 10 11, year 12 13)

4) WHAT TYPE OF FISHING EQUIPMENT DID YOU USE? |____| EQUIPMENT 14

1)Bait 2)Flies 3)Lures 4)Combination

5) DID YOU SPEND MOST OF YOUR TIME FISHING FROM A BOAT OR FROM SHORE? |____| BOAT/SHORE 15

1)Boat 2)Shore

6) HOW MUCH TIME DID YOU SPEND AT _______? |____|____|.|____| HOURS 16 17 18

(Total time spent at site, NOT the amount of time they actually fished) |___|____| DAYS 19 20

7) IF MORE THAN ONE DAY: |____|____|.|____| HOURS PER DAY 21 22 23

About how many hours a day did you fish?

7) IF LESS THAN ONE DAY: |____|____|.|____| HOURS 24 25 26

About how many hours did you fish?

8) WHAT WAS THE PRIMARY TYPE OF FISH YOU WERE TRYING TO CATCH?

9) ABOUT HOW MANY FISH (OF EACH TYPE) DID YOU CATCH AND HOW MANY DID YOU KEEP?

LIST ALL SPECIES:	CODE:	# CAUGHT	# KEPT
1)______________	|___|___|___| 27 28 29	|___|___| 30 31	|___|___| 32 33
2)______________	|___|___|___| 34 35 36	|___|___| 37 38	|___|___| 39 40
3)______________	|___|___|___| 41 42 43	|___|___| 44 45	|___|___| 46 47

The next few questions ask about some of the trip details and expenditures.

10) HOW DID YOU TRAVEL FROM YOUR HOME TO ____? MODE: CODE:

1)____________ |___|___| 55 56

(List all transportation modes)

2)____________ |___|___| 57 58

If car was driven, ASK #11 and #11a.
If NOT, go to #12.

11) WHAT TYPE OF VEHICLE WERE YOU IN? CODE |____| 59

1)Compact(4 Cylinders) 4)4W Drive
2)Intermediate(6 Cylinders) 5)Recreational
3)Full-Size(8 Cylinders)

11A) WERE YOU DRIVING, RIDING IN THE VEHICLE, OR BOTH? CODE |____| 60

1)Driving 2)Riding 3)Both

12) ABOUT HOW LONG DID IT TAKE TO TRAVEL FROM YOUR HOME TO _______? |___|___| MINUTES 61 62

(This should start when they left home and end when they arrived at the fishing site, including stops along the way.) |___|___| HOURS 63 64

|___|___| DAYS 65 66

13) COULD YOU ESTIMATE THE DISTANCE YOU TRAVELED FROM YOUR HOME TO ____? (One-way distance, sum of all modes including stops along the way) |____|____|____|____| MILES 67 68 69 70

14) WOULD YOU ESTIMATE THE AMOUNT OF MONEY YOU SPENT ON TRANSPORTATION TO AND FROM ____?

Money spent on such things as tires should not be included because they aren't specifically for the trip.

MODE	AMOUNT SPENT
|___|___| 71 72	$|___|___|___|___|.00 73 74 75 76
|___|___| 77 78	$|___|___|___|___|.00 79 80 81 82

If car or other vehicle was used, ASK #15 - #21.
If NOT, skip to #22.

15) HOW MUCH OF THIS COST WAS FOR GAS? $ GAS ONLY $|____|____|____|____|.00 83 84 85 86

16) DID YOU CONSIDER WEAR AND TEAR ON THE VEHICLE DRIVEN AS PART OF THE TRANSPORTATION COST? YES=1 NO=2 |____| 87

17) WHAT WOULD YOU ESTIMATE AS THE COST PER MILE OF WEAR AND TEAR ON THE VEHICLE DRIVEN? $|____|.|____|____| PER MILE 88 89 90

18) ON WHAT TYPE OF ROAD DID YOU SPEND MOST OF YOUR TIME TRAVELING? CODE: |____| 91

1)Interstate 2)Highway 3)Rural(paved) 4)Rural(unpaved)

19) HOW MANY PEOPLE WERE IN THE VEHICLE? |___|___| PEOPLE
92 93

20) HOW MANY OF THESE WERE FISHING AT _____? |___|___| ANGLERS
94 95

21) HOW MANY OF THESE PEOPLE FISHING WERE CHILDREN UNDER 12? |___|___| UNDER 12
96 97

The next 2 questions ask about the time you spent travelling to _____?

22) SUPPOSE YOU COULD SHORTEN YOUR TRAVEL BY ONE-HALF, SO INSTEAD OF ____(insert time from #12) IT TOOK ONLY ____(1/2 #12)TO GET FROM YOUR HOME TO ___. WHAT IS THE MAXIMUM AMOUNT YOU WOULD BE WILLING TO PAY TO REACH ____ IN HALF THE TIME YOU ACTUALLY TOOK? $|___|___|___|___|.00
98 99 100 101

If amount in #22 is 0, ASK #23. If NOT, skip to #24.

23) WHY WOULDN'T YOU PAY MORE TO REDUCE THE TIME YOU SPENT TRAVELLING? CODE |___|___|
102 103
CODE

REASONS:_______________________________

24) DID YOU ENJOY THE TIME YOU SPENT TRAVELLING TO _____? YES=1 NO=2 |___|
104

OTHER:_______________________________ OTHER CODE |___|___|
105 106

☆ The next few questions will help us to determine how much people spend on Montana fishing trips. Could you tell me how much you spent, if anything, on each of the following categories during the trip?

25)
a) LODGING, SUCH AS HOTELS, OR CAMPGROUND FEES? $|___|___|___|___|.00
107 108 109 110

% SPENT IN ROUTE? |___|___|___|%
111 112 113

% SPENT NEAR FISHING SITE? |___|___|___|%
114 115 116

b) FOOD AND BEVERAGES BOUGHT IN RESTAURANTS? $|___|___|___|___|.00
117 118 119 120

% SPENT IN ROUTE? |___|___|___|%
121 122 123

% SPENT NEAR FISHING SITE? |___|___|___|%
124 125 126

c) FOOD AND BEVERAGES BOUGHT IN STORES? $|___|___|___|___|.00
127 128 129 130

% SPENT AT HOME? |___|___|___|%
131 132 133

% SPENT IN ROUTE? |___|___|___|%
134 135 136

% SPENT NEAR FISHING SITE? |___|___|___|%
137 138 139

d) TACKLE AND BAIT BOUGHT FOR THIS TRIP? $|___|___|___|___|.00
140 141 142 143

% SPENT AT HOME? |___|___|___|%
144 145 146

% SPENT IN ROUTE? |___|___|___|%
147 148 149

% SPENT NEAR FISHING SITE |___|___|___|%
150 151 152

e) FEES FOR GUIDES OR OUTFITTERS? $|___|___|___|___|.00
153 154 155 156

f) ANY OTHER ON SITE PURCHASES SUCH AS BOAT GAS OR RENTAL, DOCKING FEES, FILM, AUTO REPAIRS, ETC. $|___|___|___|___|___|.00
157 158 159 160 161

☆ Finally, I have a few more questions about you and your household that don't relate specifically to your trip to ____, but will help us to compare the information we get from different types of anglers.

26) HOW MANY YEARS HAVE YOU BEEN FISHING? |___|___| YEARS
162 163

27) HOW MANY DAYS PER YEAR DO YOU FISH, ON THE AVERAGE? |___|___|___| DAYS PER YEAR
164 165 166

28) HOW DOES FISHING COMPARE TO OTHER TYPES OF OUTDOOR RECREATION YOU DO? CODE |___|
167

1)FAVORITE
2)ONE OF YOUR FAVORITE
3)ONE OF MANY ACTIVITIES
OTHER:_______________

29) COULD YOU ESTIMATE THE TOTAL AMOUNT OF MONEY YOU HAVE INVESTED IN FISHING RELATED EQUIPMENT SUCH AS FISHING BOATS, RODS, TACKLE BOXES, WADERS, ETC? $|___|___|___|___|___|.00
168 169 170 171 172

☆ These last questions are for statistical purposes, and will be kept in strict confidence.

30) AS I READ THE FOLLOWING AGE CATEGORIES, PLEASE INDICATE WHICH ONE YOU ARE IN. |___|
173

1) 12 - 15
2) 16 - 20
3) 21 - 29
4) 30 - 39
5) 40 - 49
6) 50 - 61
7) 62 or older

31) HOW MANY PEOPLE LIVE IN YOUR HOUSEHOLD? |___|___| PEOPLE
174 175

32) HOW MANY YEARS OF EDUCATION HAVE YOU HAD? |___|___| YEARS
176 177

33) AS I READ THE FOLLOWING INCOME CATEGORIES, PLEASE INDICATE THE CATEGORY YOUR TOTAL HOUSEHOLD INCOME BEFORE TAXES IN 1984 IS IN. INCOME |___|___|
178 179

1) 0- 5,000
2) 5,000-10,000
3) 10,000-15,000
4) 15,000-20,000
5) 20,000-25,000
6) 25,000-30,000
7) 30,000-40,000
8) 40,000-50,000
9) 50,000-75,000
10) More than 75,000

Montana Department of Fish, Wildlife & Parks

FISHERIES SURVEY

DID YOU FISH IN MONTANA DURING AUGUST 16-31

☐ YES ☐ NO

PLEASE CHECK THE TYPE OF LICENSE YOU PURCHASED

- ☐ FISHING OR FISHING/CONSERVATION COMBINATION FOR RESIDENT OR NONRESIDENT
- ☐ SPORTSMAN
- ☐ DISABLED RESIDENT CONSERVATION
- ☐ RESIDENT CONSERVATION ONLY

IF YOU ARE A PIONEER (62 OR OLDER) OR A YOUTH (12 TO 14), DO YOU PLAN ON USING YOUR CONSERVATION LICENSE TO FISH?

☐ YES ☐ NO

PLEASE REFER TO THE MAPS TO HELP US IDENTIFY THE WATERS YOU FISHED

DATE FISHED AUGUST 16-31	NAME OF LAKE OR STREAM FISHED	SECTION NUMBER IF INDICATED ON MAP	NEAREST TOWN AND/OR POINT OF ACCESS OR LANDMARK	TOTAL HOURS FISHED PER DAY	TOTAL NUMBER OF FISH CAUGHT		TOTAL NUMBER OF FISH KEPT		WAS THE MAIN PURPOSE OF YOUR TRIP TO FISH? (Y OR N)	DID YOU STAY OVERNIGHT? (Y OR N)	ROUND TRIP DISTANCE** TRAVELED
					TROUT AND SALMON	OTHER SPORT FISH*	TROUT AND SALMON	OTHER SPORT FISH*			
ENTER EACH DAY AND EACH WATER FISHED ON A SEPARATE LINE. LIST ALL FISHING IN MONTANA, NOT JUST WATERS INDICATED ON THE MAP											
AUGUST											
AUGUST											
AUGUST											
AUGUST											
AUGUST											
AUGUST											
AUGUST											
AUGUST											
AUGUST											

* SUCH AS: THE NUMBEROF WHITEFISH, WALLEYE, PERCH, BASS, ETC.

** IF YOU STAYED OVERNIGHT, PLEASE MAKE A SEPARATE ENTRY FOR EACH FISHING TRIP.

THIS INFORMATION WILL BE HELD IN STRICT CONFIDENCE AND WILL BE USED FOR MANAGEMENT PURPOSES ONLY

APPENDIX B

TRAVEL COST PARAMETER ANALYSIS

Literature Review

The travel cost method has a special measurement problem in that the visitor's perceived price is not directly observed. Typically the estimated travel cost (or supply price) for a visitor is based on no more than the estimated round trip distance to the site and published national estimates of the variable cost of automobile transportation. Even with survey evidence of the costs of travel, there is considerable variability across studies as to which travel or on-site expenditures to include. In addition, as was noted in even some of the earliest studies (Knetsch, 1963), the omission of the value of time can bias valuation estimates downward. A considerable literature has addressed the issue of how much time involved is costly and the appropriate value to place on this time (Cesario and Knetsch, 1970); Cesario, 1976; McConnell, 1975). In the following sections, the travel cost literature on transportation and time cost parameters is briefly reviewed and estimates specific to this study's sample of Montana fishermen are derived.

For the typical zonal travel cost application, only data on round trip distance is available for each origin-destination observation. In the absence of travel expenditure and travel time data for each observation, it is necessary to infer both a transportation and time cost cents/mile parameter that can be applied to round trip distance. This method implies an assumption of homogeneous travel cost per mile across zones.

Where origin-destination level data is available on both travel time and expenditure, the two variables can be included directly in the first stage demand curve model. However, aggregation in the zonal model results in strong collinearity between distance and travel time. As a result, the convention has been to use estimated variable automobile costs for a transportation cost parameter and (following Cesario, 1976) to value travel time at 25% to 50% of the wage rate. The empirical basis for applying these values is weak, since the estimates are derived from the transportation literature on urban computers. Where the individual observation travel cost model can be applied, average cost and travel time can be included as separate regressors. The estimated parameters should be unbiased, but the poor overall explanatory power of the reported estimates (Brown and Nawas, 1973; Gum and Martin, 1975) is not encouraging.

The evidence on the opportunity cost of time in recreational travel is limited and can be briefly summarized. McConnell and Strand (1981) used the individual model and the assumption that response to monetary and travel time costs should be the same. They derived an estimate of the value of travel time at 60 percent of the wage rate for a sample of sport fishermen. Desvousges et al. (1983) tested both the hypothesis that opportunity costs of time are equal to the full wage rate and the Cesario hypothesis that costs are one-third the wage. For a sample of 22 sites, each hypothesis was rejected with about the same frequency (about one-third of the cases). Desvousges et al. also made direct estimates of opportunity cost as an approximate constant multiple of the wage rate (following McConnell and

Strand, 1981); most of these estimates were either negative or greater than unity. In general, their findings appeared to be limited by the available data. In their application, Desvousges et al (1983) chose to use the full wage rate. Given the uncertainty concerning the travel time value, some analysts have used a range of values. For example, in a recent paper Bishop and Heberlein (1980) showed the sensitivity of consumer surplus estimates to time valued at zero or at 50% of the wage rate. Including travel time at 50% of the wage rate quadrupled the estimated average consumer surplus (per hunter) from $8 to $32.

The variety of approaches taken for estimating the transportation cost parameter in the recent literature can also be compared. For monetary costs, there are at least two models which can be considered in deciding on the appropriate travel cost per mile. One model describes decisions on a household basis. In this approach, taken by Knetsch and Davis (1966) for example, the costs per mile are on a vehicle or group basis. The other approach focuses on the individual and may require a measured or assumed number of individuals per vehicle to identify shared costs. Of the studies referenced above, both Desvousges et al. and Bishop and Heberlein defined monetary travel costs as the variable costs of operating an automobile, based on national estimates for 1976 of gas, oil, maintenance, and parts per vehicle-mile (around 8 to 10 cents). While both studies appear to be on an individual basis, it is not clear that vehicle costs were changed to a per-passenger-mile basis. The latter adjustment can be significant. For example, Sutherland (1982) also used a vehicle-mile cost of about 8 cents (1976 dollars), but he used a cost per individual of about 3 cents per mile based on his sample of 2.7 passengers per vehicle. These are accounting problems; a more fundamental difficulty is that there is no basis for excluding other costs of travel such as vehicle wear and tear and lodging. Such costs have been included in some other studies and can result in per-mile travel costs that are up to four times higher than those limited to vehicle operating costs. For example, Burt and Brewer (1971) regressed reported trip expenditures on distance traveled and interpreted the estimated slope coefficient as the variable monetary cost of travel.

Approach Used in Montana Angler Study

Given the considerable range of both transportation cost and opportunity cost of travel time shown in the literature, we have developed estimates specific to our sample of Montana fishermen. The variable transportation cost is estimated following Burt and Brewer; the value of time is estimated with a willingness to pay survey question. These estimates are described in the following sections. In addition, for comparison purposes we will also report consumer surplus values based on travel cost parameters recommended by the U.S. Water Resources Council (1979, 1983). Specifically, the latter has relied on Cesario's (1976) work and recommends a value between one-fourth and one-half the wage rate as a proxy for the opportunity cost of time. One-third of the wage rate is used here for illustrative purposes. It should be noted that the use of the wage rate is solely as a proxy for opportunity cost of time in all other activities and is used even if the angler would not have been working. The wage rate for our sample was derived from reported household income based on the ratio of U.S. average hourly earnings ($8.33 in 1984) to median household income ($22,415) as reported in the 1986 U.S. Statistical Abstract. Our sample median household income was $25,400, implying average hourly earnings of $9.44. At one-third the wage rate, the opportunity cost of time is $3.15 per hour based on the Water Resource Council method. Because our survey results included hours of travel and distance to the site, it was possible to calculate average speed of travel. Using our sample median of 45 miles per hour, the opportunity cost of travel time is 7.0 cents per mile.

The transportation cost estimate recommended by the U.S. Water Resource Council is limited to the variable cost of vehicle operation. The recommended source for the latter is the U.S. Department of Transportation's "Cost of Owning and Operating a Vehicle". The most recent report in this series provides costs for 1984 automobiles (large, intermediate, compact and subcompact) and passenger vans. Our survey indicated that most recreationists utilize full size or four-wheel drive vehicles (combined 69% of the sample). Only 9.1% report driving intermediate size vehicles, 14.2% compacts, and 7.4% recreational vehicles. The DOT estimates for large vehicles are taken as being the most representative for our sample. The variable cost for a large size vehicle for 1984 is 6.0 cents for maintenance, accessories, parts and tires and 9.2 cents for gas and taxes or a total of 15.2 cents per mile. With our sample average of 2.76 people per vehicle, the cost per passenger mile is 5.6 cents.

The sum of transportation (5.6 cents) and time costs (7.0 cents) using the Water Resources Council method is 12.6 cents per mile.

Before developing an alternative estimate, the limitations of using the DOT transportation cost estimate can be briefly noted. The latter may not reflect the higher vehicle operating costs associated with driving vehicles often used for recreation, recreation road driving conditions, etc. In addition, a more serious limitation of the DOT estimate is that it is based on the cost of operating a new car in the given year. By contrast, vehicles used for recreation are more likely to reflect the efficiency of the average U.S. car, which is not new but 7.4 years old (U.S. Statistical Abstract, 1985). The DOT gas cost is based on unleaded full serve gasoline. The 1984 cost used was 1.389 $/gallon which is about 20 cents higher than self serve in this period. The DOT estimates also require assumptions as to which type of car is typical (compact, intermediate, etc.) and which costs to include. The DOT reports separately estimates of depreciation, gas and oil, maintenance and parts, parking, insurance and taxes. Following U.S. Water Resources Council, we have taken maintenance and parts and gas and oil as representing the perceived variable costs of vehicle operation on the part of recreationists.

Transportation Cost Estimate

Expenditure Data

Our estimate of the transportation cost component of the cents per mile travel cost parameter is derived from our telephone survey undertaken in early fall 1985. A copy of the survey is in Appendix A. There are a total of 1505 observations in the angler mail survey. A number of observations were not useable because residence was not coded (15), distance traveled was zero (77), or water types were not in the current study (70). This leaves the total of 1343 records that were utilized in our analysis. Among other things, respondents were asked their expenditure on transportation, lodging, food, etc. [The basic expenditure data is discussed in Chapter V and shown in Table B-1]. The average total expenditure per trip per respondent was $91.59. Only about 31% of the total trip cost was for transportation. This is consistent with other recreation surveys. For example, Clawson and Knetsch (1966) report that based on a sample of 19 different surveys, transportation averaged only about 25% of total trip expenditure. Based on total trip expenses of $91.47 and an average round trip distance of 258 miles, average cents per mile is 35.5. However, the latter is not an appropriate estimate for the transportation cost parameter required by the travel cost model since it includes both fixed and distant dependent costs. In addition, the aggregated cost estimates need to be evaluated with respect to respondent perception of costs and whether the data is individual or group. These issues will be discussed in turn below.

Transportation Mode and Perceived Costs

As noted above, there is some ambiguity as to how recreationists perceive their transportation costs. The assumption of the travel cost model is that travel costs function like a supply price for visits to a given site. The problem is that only distance is unambiguously observed, not the perceived price. A preliminary issue here is what mode of travel recreationists are using. It is generally assumed that most travelers use a personal vehicle. This approach is supported by the mail survey results. Travelers were given an opportunity to record two different travel modes. For the first travel mode with 1343 respondents, 98% used a personal vehicle of some kind. Nobody took a bus or train and only 15 (1%) reported taking a plane. Another 1% either walked, motorcycled or rode a horse. Only 60 respondents reported using a second mode of transportation. Half of these also used personal vehicles and 35% reported walking. The remaining 9 respondents took a plane (3), rode a horse (4) or motorcycled (2). These results indicate that it is appropriate to focus on the costs of driving for transportation costs and that the travel cost model assumption of relatively homogeneous costs across zones is appropriate. As noted above a high proportion of the respondents reported using four-wheel drive (33%) and large size (36%) vehicles suggesting that recreational vehicle travel costs might be higher than national averages for all types of travel.

A specific problem with respect to the costs of driving is that it is not clear whether recreationists are traveling as though costs were only out of pocket (gas, repairs) or included other variable costs such as wear and tear or depreciation. Several questions were included in the mail survey to attempt to resolve this issue. Respondents were explicitly asked (No. 16, Appendix A) if they considered wear and tear on the vehicle as part of their transportation cost. A very large majority of respondents (83% or 893 respondents) stated that they did not consider wear and tear part of their trip cost. Respondents were also asked to estimate wear and tear cost in cents per mile, but over 80% of responses showed zero cost or a median of zero. A related finding was that the reported trip costs for transportation and for gasoline were very similar, with average reported gas costs accounting for 93% of the reported transportation cost. In fact, reported gas cost and transportation cost were identical in 1084 of the 1310 cases where both were reported. The preliminary conclusion here is that when the recreationist's perceived vehicle costs are limited to using national estimates of vehicle costs, only the gasoline component (not parts and repairs) may be appropriate for inclusion.

Cost Allocation

A second issue in interpreting travel expenditures is whether the data is individual or group (vehicle basis). If the expenditure data is on a vehicle basis, but the trips are for individuals, then it is appropriate to divide per mile expenses by the number of passengers per vehicle. In the mail survey, questions were phrased to elicite expenditure by the individual (eg. "the amount of money you spent on...", Appendix A). In order to validate transportation expenditures and to analyze how vehicle expenses were shared, respondents were asked whether they were drivers, riders or both. Drivers comprised 58% of the sample, riders (passengers) were 36% and another 6% rode and shared driving. The sample was also crosstabulated by the number of people per vehicle by driver type (Table B-2); for example, only about 10% of the recreationists sample drove alone while about 40% traveled two to a car. Three different means were calculated to compare trip cost sharing: average gasoline cost in dollars per mile (AGASCTM), average total trip costs (including gas, food, lodging, tackle, etc.) (AVTLCST), and average total cost excluding gas (ANGCST). These means are shown in Table B-2 by number of people per vehicle and driver type. The sample with full information on costs is 1214 observations. To exclude outliers, observations were restricted to AGASCTM<.30 (implying at least four miles per gallon) and AVTLCST<2.0. This reduced the sample by only about 6%. The basic findings are as follows.

With respect to average gas costs, the cost reported by drivers was significantly greater than the cost reported by riders. At all passenger levels, riders reported paying around 7 cents per mile and drivers reported paying around 11 cents (Table B-2). The AGASCTM for drivers did not vary significantly with the number of people per vehicle, but did increase somewhat. Reported gas costs can be compared to other independent estimates of vehicle operating costs. Average gas costs for the Western U.S. region reported by the Bureau of Labor Statistics for April to August 1985 was $1.23 per gallon. Average miles per gallon for all cars, for example in 1983, was 15.1 (Statistical Abstract of the U.S.). This implies 8.1 cents per mile and reflects an average vehicle age of seven years. The costs for drivers alone are 9.7 cents and range up to 12.0 cents with four passengers. These numbers are slightly higher than 8.1 cents but not implausible given that "fishing cars" may be older and somewhat less efficient than the U.S. average. Also as noted above low efficiency modes (4WD, etc.) may be more predominant in the recreationist sample. When results were disaggregated for several transport modes (intermediate and full size vehicles) means were 10.4 cents and 11.6 cents or 13.7 to 10.9 miles per gallon respectively. These are also plausible compared to the Statistical Abstract average. By contrast, the Department of Transportation estimates for 1984 range from 4.4 cents to 7.0 cents for subcompact to large vehicles. These are of course based on new 1984 cars and imply 27 to 17 miles per gallon. It would appear that these are not a good basis for estimating average recreation vehicle costs.

Variable gas costs were also estimated by regressing reported total gas cost on reported round trip distance in miles. When the sample was disaggregated by vehicle type, the intercept was not significantly different from zero in four out of five cases and the coefficient on distance was 7.2 to 10.6 cents per mile. The adjusted R square statistic ranged from .50 to .93 indicating a strong correlation between the distance and gas cost responses. When the sample was disaggregated by driver type, the coefficient on distance was 9.1 cents per mile (683 observations and an adjusted R square of .54) for the driver subsample. This result implies an average miles per gallon for the sample of 13.5 This is certainly plausible compared to national average vehicle efficiency especially given the proportion of large size and four-wheel drive vehicles in the sample.

While the gas costs reported by drivers may be consistent with actual vehicle costs, the sum of implied driver and rider gas costs is not. For example (Table B-2), for the driver plus one rider case, implied total vehicle gas costs are 18 cents per mile (10.5 cents for the driver plus 7.5 cents for the rider). For the driver plus two passenger case, implied cost is 22.2 cents and for three passengers, 32.4 cents. In fact, the gas expenditure reported by both riders and drivers does not vary significantly with the number of passengers. Rather than rider and drivers for example sharing gas costs equally, it appears that riders feel obligated to pay approximately half the gas cost independent of the number of other passengers.

Another perspective on the rider/driver gas cost sharing is derived by examining average gas cost when observations of zero expenditures are excluded. For example in Table B-3, only about 5% of all drivers report zero gas expenditure. This proportion is generally independent of the number of people per vehicle. Some share of even the drivers traveling alone report zero gas expenditure; this is to be expected since it will not be necessary to fill the gas tank on every trip. (Parenthetically, the lack of a perfect correlation between gas expense and distance, even when disaggregated by mode type, may be explained in part by the random distribution of gasoline in the car at the start of a trip, tank size, and the vehicle's mile/gallon efficiency.) Excluding zero expenditure observations for drivers results in little change in the average gas cost per mile. By contrast, 30 to 50% of riders report zero gas expenditure. When there are only two people per vehicle, 70 % of the riders report paying some gasoline cost. This drops to 50% to 60% of riders reporting some gas expenditure with more passengers. Interestingly, when zero expenditures are excluded, the average gas cost reported by riders is very similar to that reported by drivers (around 11 cents per mile, Table B-3) and does not vary significantly across the number of passengers. In short, about half the time riders report paying gas costs, and when they do pay on average they pay for all the gas.

Given the consistency of the disaggregated reported average gasoline costs with actual gas costs and vehicle efficiency, it would appear that the reported costs are valid. However, the sum of rider and driver gas expenditure clearly exceeds actual vehicle costs. It may be that drivers typically actually pay for the gasoline, and are later reimbursed in many cases by riders. Drivers appear to be reporting their gross gasoline expenditure, rather than expenditure net of reimbursement by riders. It might be argued that all we know about perceived costs are reported costs. Drivers may be making trip choices based on gross expenditure, since rider contributions are not certain but generally offered after the fact as a courtesy. The more conservative approach would be to limit gasoline expenditure to net out of pocket costs. This is easily done by only including driver gasoline expenditures in total trip costs, and setting all rider gas expenditure at zero.

Variable Transportation Costs

Variable trip costs were estimated by regressing total expenditure on distance. Three alternative definitions of total trip expenditure were used: TOTLCST1 (sum of reported transportation, lodging, restaurant and store-bought food, tackle, guiding fees and other); TOTLCST2 (same as 1 but substituting gasoline cost for transportation cost); and TOTLCST3 (same as 2 but counting only driver gasoline expenditures). For the full sample of 1248 observations, the respective coefficients on distance were 27.6, 24.5 and 22.4 cents per mile (Table B-4). The cents per mile variable cost estimates are not extremely sensitive to the different definitions of total cost. A conservative estimate of monetary transportation costs would be to use the 22.4 cents per mile. It may be noted that a large share of the variation in total costs was explained by distance in this simple model, with the coefficient of determination (adjusted R square) varying from .47 to .54. Fixed trip costs (intercept) were 12 to 15 dollars. Distance dependent total costs (based on a sample average of about 260 miles round trip) averaged around 70 dollars or about 85% of total costs.

The sample was also disaggregated by residents and nonresidents as a partial test of whether variable travel costs were relatively homogeneous across zones. In fact, variable travel costs were very similar between the two samples (Table B-4). For example, using the TOTLCST3 definition of trip expenditures, the coefficients are 20.7 and 20.5 cents per mile for residents and nonresidents respectively. However, the fixed trip costs (intercept) vary considerably: 64 dollars for nonresidents and 11 for residents.

Several travel cost on distance regressions were also tried that included the number of people per vehicle. This variable was not significant.

Opportunity Cost of Time Estimate

Average Willingness to Pay

As described previously, a sample of individuals holding Montana fishing licenses was asked how much they would pay to shorten their reported travel time by one-half (Appendix A). Average willingness to pay (dollars per hour) for each fisherman was calculated by dividing the reported amount by one-half reported travel time. The mean willingness to pay for the entire sample (1166 observations) was 11.50 per hour. However, the sample median is zero since over 80% were reportedly willing to pay nothing to reduce travel time. The mean of 11.50 results from a skewed distribution that includes some implausibly high values. As an example, there were 152 observations (13% of the sample) where the average willingness to pay per hour exceeded the reported household wage rate. The mean of this subsample was $83.07 per hour (Table B-5). When these high values are excluded, the mean drops to $.77 (based on 1014 observations).

While the majority of responses indicated zero opportunity cost of travel, the nonzero responses appear to be logically related to residence, income, and whether or not the trip was judged to be "enjoyable" (Appendix A). For example, nonresidents were almost three times as likely to be willing to pay some amount to reduce travel time as residents: 44% of nonresidents were willing to pay versus 18% of residents. Most anglers reported enjoying their travel (over 90%). However, those who reported not enjoying their travel were about twice as likely to be willing to pay as those who did not. For non-residents 71% of those who did not enjoy the travel were willing to pay. Compared to the entire sample, the subgroup who were willing to pay something (but less than the reported household wage) had much higher mean household income ($38,716 versus $28,239) and reported significantly higher one-way travel time (7.2 hours versus 2.8).

Regression Analysis

The relationship between the amount fishermen were willing to pay and explanatory variables was estimated using the following model:

$$(SHORTENi)=Bo+B1(HHTIMi)+B2(RTDISTi)+B3(SINCOMEi)+Ei$$

where:

SHORTENi = amount angler i would pay to reduce travel time

HHTIMi= one half reported travel time

RTDISTi= round trip distance in miles

SINCOMEi= mean of reported income interval

and Bj are parameters to be estimated and Ei is an error term.

The coefficient on the travel time variable in this model (B1) can be interpreted as an estimate of the opportunity cost of travel in dollars per hour, corrected for the independent effects of income and distance. The hypothesis is that the amount fishermen are willing to pay to reduce travel time is positively related to hours traveled, income, and distance. The model was estimated with an OLS stepwise regression package. The basic finding is that the opportunity cost of travel is relatively stable across subsamples at around $2.00 to $3.00 per hour (Table B-6).

For the entire sample, the estimate is $2.30. The result for the subsample with average willingness to pay less than the reported household wage is quite similar, $2.06. The result for the small subgroup with positive amount (but less than household wage) is $2.81. In all cases, all three variables were significant and had the expected signs. Not surprisingly, there is some multicollinearity between distance and travel time (with simple correlations of around .6 to .7). While the estimated correlations should be unbiased, the standard errors of the regression parameter may tend to be high. In fact, the 95% confidence interval on B1 for the full sample is $.05 to $4.55 and for the small subsample of positive amounts only is $1.14 to $4.47 (Table B-6). It might be argued that the estimate should be restricted to the subsample of fishermen with average willingness to pay less than the household wage rate. This clearly results in the most conservative estimate ($2.06) and this estimate also has a much lower standard error and 95% correspondingly smaller confidence interval ($1.49 to $2.63).

Taking $2.06 as our estimate of the opportunity cost of time (and assuming 45 miles/hour travel speed) results in a 4.6 cents per mile time cost parameter. This estimate is a little over half that derived using the Water Resources Council method and implies an opportunity cost of time that is about one-fifth of the household wage rate. The sum of time and transportation costs for both methods (12.6 cents and 27.0 cents) is derived in Table B-7.

The linear formulation of the regression model above reflected the assumption that the opportunity cost of travel is constant across zones. This assumption was tested with several alternative specifications. When the natural log of hours of travel was included as an independent variable in place of hours, it was not found to be significantly correlated to the amount anglers would pay. This finding supports the hypothesis of constant time costs. When a squared hours term was included, it was significant in all cases. However, hours of travel and squared hours are highly multicollinear (correlation of over .80 in all samples) and the HHRTIM variable became insignificant in two cases and negative in another. It appears that the assumption of constant time costs is a reasonable one.

Conclusions

This analysis suggests that the travel expenditures reported are on an individual basis (accordingly it is not appropriate to divide by the number of people per vehicle). Transportation expenditures are almost identical to reported gasoline expenditures. Perceived vehicle travel costs appear to be limited to out of pocket expense for gasoline, and exclude wear and tear. The analysis of rider and driver cost sharing indicated that drivers are reporting gross expenditure and not netting out rider contributions. Driver gasoline expenditures appear to be consistent with independent estimates of actual gasoline costs and vehicle efficiency. A conservative estimate of total trip expenditures includes only driver reported gasoline expenditure (excludes riders' reported gas costs). Based on the latter, variable trip costs are 22.6 cents per mile per individual. Based on a disaggregation of resident and nonresident trips, variable travel costs appear to be homogeneous across zones. The opportunity cost of recreational travel time based on willingness to pay survey data is estimated at one-fifth the wage rate or somewhat less than the lower range of the values derived from studies of urban commuters. The two alternative levels of travel cost per mile for this study are 12.6 cents based on the Water Resource Council method and 27 cents based on our sample of Montana fishermen.

Table B-1. Summary of angler expenditure variables.

Variable	Dollars Per Trip Mean
Transportation	28.24
Lodging Fees	13.06
Food-Restaurant	13.08
Food-Stores	25.18
Tackle	6.55
Guide	1.63
Other	3.86
Total Cost	**91.59**
Avg. Cost (per mile round trip)	35.5
Round trip distance	257.9

Note: Total observations = 1343

Table B-2. Allocation of gasoline costs and total trip costs among drivers and riders[1].

Variable[3]	Rider or Driver	Number of People per Vehicle 1	2	3	4
AGASCTM	Driver	.097[2] (.006) n=102	.105 (.004) n=304	.110 (.005) n=128	.120 (.008) n=90
	Rider		.075 (.005) n=178	.056 (.007) n=107	.068 (.008) n=96
AVTLCST	Driver	.236 (.029) n=102	.300 (.014) n=304	.365 (.030) n=128	.457 (.036) n=90
	Rider		.239 (.016) n=178	.271 (.031) n=107	.338 (.034) n=96
ANGCST	Driver	.139 (.027) n=102	.195 (.013) n=304	.255 (.029) n=128	.337 (.034) n=90
	Rider		.164 (.014) n=178	.215 (.029) n=107	.270 (.031) n=96

Notes:

[1] Excluding outliers: AGASCTM is less than .30 and ATLCST is less than 2.00 or exclude about 6% of sample.

[2] Means, with standard error in parenthesis and n indicating sample size.

[3] Variable definitions: AGASCTM = Average gasoline cost in dollars per mile.

AVTLCST = Total trip costs (gas, food, lodging, guiding fees, tackle) ($/mile)

ANGCST = Average non-gas total costs

Table B-3. Comparison of average gas cost per mile for riders and drivers.

No. of People per Vehicle	Driver Mean	Driver % zero	Driver non-zero mean	Rider Mean	Rider % zero	Rider non-zero mean
1	.097 (102)*	8	.105 (94)			
2	.105 (304)	5	.111 (288)	.075 (178)	30	.108 (124)
3	.110 (128)	5	.116 (121)	.056 (107)	51	.115 (52)
4	.120 (94)	4	.131 (86)	.068 (96)	42	.117 (56)

* Number of observations in parenthesis

NOTE: Rule for excluding outliers: AVTLTCST is less than 2.00
AGASCTM if less than .3

Table B-4. Total cost regressed on distance.

Dependent Var	a	b	R^2	residual df
Complete Sample				
TOTLCST1	12.151 (2.893)	.276 (38.408) 95%: .261-.290	.542	1247
TOTLCST2	16.847 (4.236)	.245 (36.137) 95%: .232-.259	.511	1247
TOTLCST3	13.453 (3.406)	.224 (33.257) 95%: .211-.238	.470	1247
Residents				
TOTLCST1	11.619 (3.909)	.251 (19.013) 95%: .225-.276	.251	1074
TOTLCST2	11.545 (3.938)	.239 (18.41) 95%: .214-.265	.239	1074
TOTLCST3	10.93 (3.761)	.207 (16.088) 95%: .182-.232	.193	1074
Nonresidents				
TOTLCST1	51.96 (1.668)	.261 (12.316) 95%: .219-.303	.467	171
TOTLCST2	81.353 (2.831)	.219 (14.201) 95%: .180-.258	.420	171
TOTLCST3	63.66 (2.215)	.205 (10.479) 95%: .166-.244	.388	171

Notes: t-statistic in parenthesis. 95% is 95% confidence interval on the slope coefficient. "Residual df" is residual degrees of freedom.

Definition of Variables: TOTLCST1= Sum of reported expenditures for transportation, lodging, restaurant and store-bought food, tackle, guide fees and other.

TOTLCST2= Same as 1 but substituting gasoline expenditure for transportation.

TOTLCST3= Same as 2 but including only driver gasoline expd.

Table B-5. Average willingness to pay to shorten travel time (dollars/hour).

Statistic					
				WTP equals zero	
Mean	std. error	Median	n	n	%
	A.) WTPSHORT is less than HHWAGE				
.773	.103	0.0	1014	940	93
	B.) WTPSHORT is greater than 0 and less than HHWAGE				
10.591	.779	10.0	74	-	-
	C.) WTPSHORT is greater than HHWAGE				
83.07	35.60	29.29	152	-	-

Where WTPSHORT = amount willing to pay to shorten travel time (dollars/hour)

HHWAGE = household wage rate.

Table B-6. Regression results of willingness to pay to reduce travel time.

A. Estimated Parameters

Sample	df	R^2	intercept	HRTIM/2	RTDIST	INCOME
All	1165	.120	-16.74 (-3.262)	2.299 (2.006)	.0426 (6.41)	.000659 (4.098)
WTP<HHW	1011	.238	5.982 (4.835)	2.062 (7.112)	.0103 (5.335)	.000128 (3.331)
0/WTP<HHW	71	.676	-34.26 (-2.67)	2.807 (3.365)	.0498 (7.052)	.000840 (2.709)

B. 95% confidence interval for coefficient on HRTIM/2

All	.051 to 4.547
WTP<HHW	1.493 to 2.631
O<WTP<HHW	1.144 to 4.471

Notes: Estimated quation:

$$SHORTEN = B_0 + B_1 (HRTIM/2) + B_2 RTDIST + B_3 INCOME$$

where: SHORTEN = amount willing to pay to reduce travel time, HRTIM/2 = 1/2 travel time; RTDIST = round trip distance, INCOME = average income.

Values in parenthesis are t-statistics

Table B-7. Travel cost parameters (cents per mile).

	Transportation Cost	Opportunity Cost of Time	Sum
Water Resources Council Method	5.6	7.0	12.6
Montana Sample	22.4	4.6	27.0

APPENDIX C

Stream Benefit Estimates Using Predicted Trips

As noted in the text, lake benefit estimates are based on use of a predicted intercept while stream estimates are based on an actual trip intercept (Gum and Martin method). In order to provide a more direct comparison to the lake estimates, stream estimates based on a predicted intercept are reported in this appendix.

Table C-1 presents values per day and trip by site for the standard cost approach using predicted trips as the intercept. The overall site average per trip is $62.27 which is slightly higher (about 15%) than the estimate based on actual trips ($53.08, Table 7). Being based on actual trips, the site specific values in Table 7 may be more reliable. The estimates for some sites differ considerably across the two methods. For example in Table C-1 (predicted intercept approach), the Upper Yellowstone and Middle Yellowstone are valued about the same at $14.56 and $14.88 per trip respectively. This is about the same as the value placed on trips to the Milk River ($16.87). Based on relative quality of the fishery (and ignoring location), one would expect the Upper Yellowstone to be valued more highly. When actual trips are used as the intercept (Table C-1), the Upper Yellowstone jumps to $107.50 per trip and the Middle Yellowstone to $29.35. By comparison, the Milk River drops to $10.57. Site specific values are clearly quite sensitive to using predicted intercept versus the Gum and Martin approach. It appears that site values based on the latter may be more reliable. The differences across sites are discussed in greater detail in the previously referenced sensitivity analysis technical paper. As noted previously, the comparative analysis of TCM and CVM approachs on Duffield and Allen (1987) appears to provide evidence that for streams, the Gum and Martin approach is more reliable.

Table C-2 provides values per trip by site for reported costs. Total recreational values by site based on the predicted trips approach are provided in Tables C-3 and C-4. The aggregate estimates are slightly higher than the corresponding estimates in Tables 9 and 10 (based on actual trips).

Table C-1. Montana streams net economic value per trip, equation without site attribute data (standard cost).

RIVER CODE NO.	RIVER	VALUE PER TRIP	AVG DAYS PER TRIP	VALUE PER DAY	NO. OF ZONES
12	MIDDLE FORK FLATHEAD	22.49	1.13	19.99	7
14	NORTH FORK FLATHEAD	71.56	1.30	54.86	10
15	FLATHEAD	39.27	1.10	35.70	18
16	LOWER CLARK FORK	81.58	1.13	72.44	20
17	KOOTENAI TRIBS	44.27	1.08	41.11	11
21	U. CLARK FORK TRIBS	26.82	1.00	26.82	16
22	BLACKFOOT TRIBS	55.89	1.18	47.38	11
24	BITTERROOT TRIBS	48.95	1.09	44.75	16
25	MID. CLARK FORK TRIBS	41.01	1.11	36.91	9
31	U. YELLOWSTONE TRIBS	84.11	1.11	75.93	24
32	GALLATIN TRIBS	45.83	1.09	42.01	14
33	U. MISSOURI REGION 3	58.31	1.02	57.26	16
34	MADISON TRIBS	174.46	1.29	135.30	23
35	JEFFERSON	18.33	1.05	17.52	20
36	BEAVERHEAD TRIBS	86.54	1.21	71.52	26
37	BIG HOLE TRIBS	23.17	1.15	20.19	17
41	MIDDLE MISSOURI	93.92	1.02	92.06	18
42	SMITH TRIBS	4.42	1.04	4.25	6
43	U. MISSOURI REGION 4	52.71	1.04	50.70	27
44	MARIAS	48.67	1.23	39.52	19
52	MID. YELLOWSTONE TRIBS	64.68	1.07	60.28	35
53	MUSSELSHELL	5.09	1.13	4.49	11
55	STILLWATER TRIBS	35.69	1.15	31.03	7
62	MILK	16.87	1.00	16.87	6
71	LOWER YELLOWSTONE	55.24	1.00	55.24	8
80	BEAVERHEAD	114.40	1.17	98.05	19
81	BIG HOLE	100.06	1.51	66.35	37
82	BITTERROOT	26.63	1.05	25.47	12
83	BLACKFOOT	80.31	1.01	79.25	26
84	BOULDER	133.66	1.33	100.24	16
85	BIGHORN	150.88	1.29	117.19	28
86	UPPER CLARK FORK	31.28	1.01	30.95	16
87	MIDDLE CLARK FORK	37.12	1.05	35.43	17
88	EAST GALLATIN	19.10	1.03	18.60	10
89	UPPER FLATHEAD	8.10	1.02	7.98	12
90	GALLATIN	92.26	1.06	87.01	31
91	KOOTENAI	65.83	1.02	64.76	11
92	MADISON	138.77	1.45	95.40	55
93	MISSOURI HOLTER-CASC	96.37	1.19	80.95	26
94	ROCK CREEK	164.97	1.30	126.57	21
95	SMITH	56.95	1.33	42.96	14
96	STILLWATER	127.30	1.21	105.16	15
97	SWAN	28.71	1.08	26.66	10
98	UPPER YELLOWSTONE	14.56	1.10	13.25	32
99	MIDDLE YELLOWSTONE	14.88	1.01	14.80	17
	SITE AVERAGES	62.27	1.13	53.14	

Table C-2. Montana streams net economic value per trip, equation without site attribute data (reported cost).

RIVER CODE	RIVER	VALUE PER TRIP	AVG DAYS PER TRIP	VALUE PER DAY	NO. OF ZONES
12	MIDDLE FORK FLATHEAD	48.19	1.13	42.83	7
14	NORTH FORK FLATHEAD	153.35	1.30	117.57	10
15	FLATHEAD	84.14	1.10	76.49	18
16	LOWER CLARK FORK	174.82	1.13	155.22	20
17	KOOTENAI TRIBS	94.86	1.08	88.09	11
21	UPPER CLARK FORK TRIBS	57.47	1.00	57.47	16
22	BLACKFOOT TRIBS	119.76	1.18	101.53	11
24	BITTERROOT TRIBS	104.89	1.099	95.90	16
25	MID. CLARK FORK TRIBS	87.88	1.11	79.09	9
31	U. YELLOWSTONE TRIBS	180.23	1.11	162.70	24
32	GALLATIN TRIBS	98.20	1.09	90.01	14
33	U. MISSOURI REGION 3	124.95	1.02	122.69	16
34	MADISON TRIBS	373.84	1.29	289.92	23
35	JEFFERSON	39.27	1.05	37.53	20
36	BEAVERHEAD TRIBS	185.45	1.21	153.26	26
37	BIG HOLE TRIBS	49.65	1.15	43.27	17
41	MIDDLE MISSOURI	201.25	1.02	197.27	18
42	SMITH TRIBS	9.48	1.04	9.11	6
43	U. MISSOURI REGION 4	112.94	1.04	108.64	27
44	MARIAS	104.30	1.23	84.68	19
52	MID. YELLOWSTONE TRIBS	138.60	1.07	129.18	35
53	MUSSELSHELL	10.91	1.13	9.63	11
55	STILLWATER TRIBS	76.48	1.15	66.50	7
62	MILK	36.15	1.00	36.15	6
71	LOWER YELLOWSTONE	118.38	1.00	118.38	8
80	BEAVERHEAD	245.13	1.17	210.11	19
81	BIG HOLE	214.41	1.51	142.18	37
82	BITTERROOT	57.07	1.05	54.59	12
83	BLACKFOOT	172.09	1.01	169.81	26
84	BOULDER	286.41	1.33	214.80	16
85	BIGHORN	323.32	1.29	251.12	28
86	UPPER CLARK FORK	67.02	1.01	66.31	16
87	MIDDLE CLARK FORK	79.54	1.05	75.92	17
88	EAST GALLATIN	40.93	1.03	39.85	10
89	UPPER FLATHEAD	17.35	1.02	17.10	12
90	GALLATIN	197.71	1.06	186.45	31
91	KOOTENAI	141.07	1.02	138.78	11
92	MADISON	297.35	1.45	204.43	55
93	MISSOURI HOLTER-CASC	206.51	1.19	173.47	26
94	ROCK CREEK	353.51	1.30	271.23	21
95	SMITH	122.03	1.33	92.06	14
96	STILLWATER	272.78	1.21	225.34	15
97	SWAN	61.52	1.08	57.13	10
98	UPPER YELLOWSTONE	31.20	1.10	28.40	32
31.90	MIDDLE YELLOWSTONE	31.90	1.01	31.71	17
	SITE AVERAGES	133.43	1.13	113.87	

Table C-3. Montana streams, total recreational value by site (standard cost).

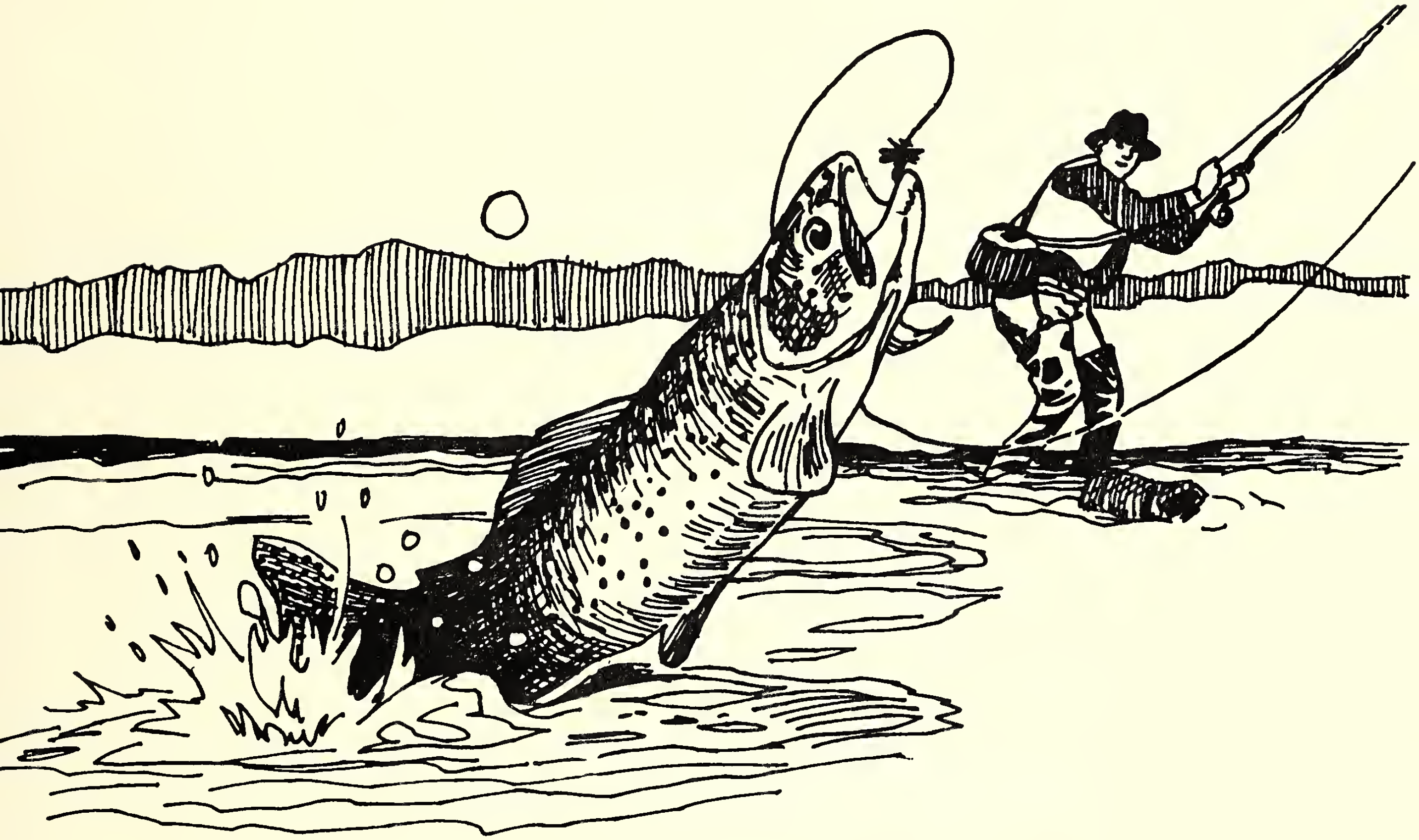
RIVER CODE	RIVER	VALUE PER DAY	FISHING PRESSURE	SITE VALUE ($1000)
12	MIDDLE FORK FLATHEAD	19.99	5851	117
14	NORTH FORK FLATHEAD	54.86	8037	441
15	FLATHEAD	35.70	35545	1269
16	LOWER CLARK FORK	72.44	21237	1538
17	KOOTENAI TRIBS	41.11	26081	1072
21	UPPER CLARK FORK TRIBS	26.82	24207	649
22	BLACKFOOT TRIBS	47.38	9075	430
24	BITTERROOT TRIBS	44.75	33676	1507
25	MIDDLE CLARK FORK TRIBS	36.91	6835	252
31	UPPER YELLOWSTONE TRIBS	75.93	12424	943
32	GALLATIN TRIBS	42.01	14045	590
33	U. MISSOURI REGION 3	57.26	25419	1455
34	MADISON TRIBS	135.30	11224	1519
35	JEFFERSON	17.52	29129	510
36	BEAVERHEAD TRIBS	71.52	25878	1851
37	BIG HOLE TRIBS	20.19	18621	376
41	MIDDLE MISSOURI	92.06	22340	2057
42	SMITH TRIBS	4.25	7143	30
43	U. MISSOURI REGION 4	50.70	67557	3425
44	MARIAS	39.52	5925	234
52	MIDDLE YELLOWSTONE TRIBS	60.28	30132	1816
53	MUSSELSHELL	4.49	11218	50
55	STILLWATER TRIBS	31.03	13002	404
62	MILK	16.87	5965	101
71	LOWER YELLOWSTONE	55.24	995	55
80	BEAVERHEAD	98.05	24239	2377
81	BIG HOLE	66.35	47910	3179
82	BITTERROOT	25.47	56024	1427
83	BLACKFOOT	79.25	28794	2282
84	BOULDER	100.24	17429	1747
85	BIGHORN	117.19	44814	5252
86	UPPER CLARK FORK	30.95	17578	544
87	MIDDLE CLARK FORK	35.43	30414	1078
88	EAST GALLATIN	18.60	6191	115
89	UPPER FLATHEAD	7.98	15262	122
90	GALLATIN	87.01	63871	5557
91	KOOTENAI	64.76	22591	1463
92	MADISON	95.40	108712	10371
93	MISSOURI HOLTER-CASC	80.95	72788	5892
94	ROCK CREEK	126.57	27881	3529
95	SMITH	42.96	11824	508
96	STILLWATER	105.16	32857	3455
97	SWAN	26.66	8746	233
98	UPPER YELLOWSTONE	13.25	52016	689
99	MIDDLE YELLOWSTONE	14.80	31156	461
	STATE TOTAL		**1192658**	**72972**

Table C-4. Montana streams, total recreational value by site (reported cost).

RIVER CODE	RIVER	VALUE PER DAY	FISHING PRESSURE	SITE VALUE ($1000)
12	MIDDLE FORK FLATHEAD	42.83	5851	251
14	NORTH FORK FLATHEAD	117.57	8037	945
15	FLATHEAD	76.49	35545	2719
16	LOWER CLARK FORK	155.22	21237	3297
17	KOOTENAI TRIBS	88.09	26081	2297
21	UPPER CLARK FORK TRIBS	57.47	24207	1391
22	BLACKFOOT TRIBS	101.53	9075	921
24	BITTERROOT TRIBS	95.90	33676	3230
25	MIDDLE CLARK FORK TRIBS	79.09	6835	541
31	UPPER YELLOWSTONE TRIBS	162.70	12424	2021
32	GALLATIN TRIBS	90.01	14045	1264
33	U. MISSOURI REGION 3	122.69	25419	3119
34	MADISON TRIBS	289.92	11224	3254
35	JEFFERSON	37.53	29129	1093
36	BEAVERHEAD TRIBS	153.26	25878	3966
37	BIG HOLE TRIBS	43.27	18621	806
41	MIDDLE MISSOURI	197.27	22340	4407
42	SMITH TRIBS	9.11	7143	65
43	U. MISSOURI REGION 4	108.64	67557	7340
44	MARIAS	84.68	5925	502
52	MIDDLE YELLOWSTONE TRIBS	129.18	30132	3892
53	MUSSELSHELL	9.63	11218	108
55	STILLWATER TRIBS	66.50	13002	865
62	MILK	36.15	5965	216
71	LOWER YELLOWSTONE	118.38	995	118
80	BEAVERHEAD	210.00	24239	5093
81	BIG HOLE	142.18	47910	6812
82	BITTERROOT	54.59	56024	3058
83	BLACKFOOT	169.81	28794	4890
84	BOULDER	214.80	17429	3744
85	BIGHORN	251.12	44814	11254
86	UPPER CLARK FORK	66.31	17578	1166
87	MIDDLE CLARK FORK	75.92	30414	2309
88	EAST GALLATIN	39.85	6191	247
89	UPPER FLATHEAD	17.10	15262	261
90	GALLATIN	186.45	63871	11909
91	KOOTENAI	138.78	22591	3135
92	MADISON	204.43	108712	22224
93	MISSOURI HOLTER-CASC	173.47	72788	12627
94	ROCK CREEK	271.23	27881	7562
95	SMITH	92.06	11824	1088
96	STILLWATER	225.34	32857	7404
97	SWAN	57.13	8746	500
98	UPPER YELLOWSTONE	28.40	52016	1477
99	MIDDLE YELLOWSTONE	31.71	31156	988
	STATE TOTAL		**1192658**	**156376**

ANGLER PREFERENCE STUDY FINAL ECONOMICS REPORT

Contingent Valuation of Montana Trout Fishing by River and Angler Subgroup



September 1988

Montana Department of Fish, Wildlife & Parks

Angler Preference Study
Final Economics Report

CONTINGENT VALUATION OF MONTANA TROUT FISHING BY RIVER AND ANGLER SUBGROUP

Prepared for
Montana Department of Fish, Wildlife and Parks

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EXECUTIVE SUMMARY

Objectives

The major objective of this study was to provide contingent valuation estimates of net economic values for trout fishing on nineteen Montana rivers. A secondary objective was to estimate the net value associated with changes in fishery quality. Specifically, angler net willingness to pay was estimated for improved chances to catch larger trout and improved chances to catch more trout. The general approach to both of these objectives was to estimate economic models of demand for recreation opportunities. A related third objective was to explore the issue of market definition, in this case the types of recreation experience. Fishing, or even more narrowly trout fishing on Montana rivers, is an activity with many different styles, settings, technologies and purposes. Because of this, the fishing experience varies considerably from one angler to the next. By defining different angler types, it is possible to show how net economic values vary across user groups.

This study is based on the Angler Preference Survey administered by the Montana Department of Fish, Wildlife and Parks in the summer and fall of 1986. A description and analysis of survey findings with respect to angler characteristics, preferences, behavior and attitudes is provided in a companion study by Allen (1987). The latter includes a discussion of angler perception of river and fisheries management policies.

Methods

Net economic values are defined here as net willingness to pay. The latter is the net difference between the maximum an individual would be willing to pay before foregoing the use of a resource or commodity and the amount they must actually pay. Many federal agencies are required by the U.S. Water Resource Council Principles and Guidelines to use the net willingness to pay concept to measure the economic value of both marketed and nonmarket goods.

The basic approach used to estimate net economic values was the contingent valuation method (CVM). This is one of two basic methods that are recommended by the Water Resources Council for valuing recreation. (The other is the travel cost model.) The CVM method uses survey techniques to ask people about the values they would place on nonmarket commodities if markets did exist. Two specific versions of the CVM method were employed: open-ended and dichotomous choice. In the open-ended CVM approach individuals were asked "What is the maximum increase in your actual trip cost you would have paid to fish the (name of river fished) instead of having to fish elsewhere______(dollars)?" In the dichotomous choice approach, individuals were asked "...would you still have made the trip if your share of expenses had been (dollar bid amount) more? ___yes ___no". In the latter, the bid amount was randomly varied from $1 to $500 and respondents indicated a yes or no response. Similar questions were developed to identify net economic values for doubled chances of catching large trout or more trout.

The analysis of the open-ended CVM is fairly simple; one merely calculates the mean of the dollar responses. One problem with this method is in interpreting extreme values: either zero response or very high values. Another problem is that respondents may find it a difficult question to answer. By contrast, the dichotomous choice question requires only a yes or no to a given dollar amount. The disadvantage of the dichotomous choice approach is that a fairly complex analysis is required in order to determine net willingness to pay. Basically, the data is used to estimate how the probability of a "yes" response varies with the bid amount and other explanatory variables such as income. The analysis reported below assumed a standard logistic probability distribution function; accordingly the specific dichotomous choice model estimated here is conventionally referred to as a logit model. The mean net willingness to pay is derived by integrating the logit function from zero to the upper limit of sample bids (in this case $500).

The basic method used to determine angler types was a cluster analysis. The survey included a list of 17 possible reasons for fishing a specific river on the angler's most recent trip. The reasons include "to catch large trout", "to catch many trout", "to be with my family", "to experience solitude", etc. The respondent ranked the reasons on a four interval scale from "very important" to "not at all important". The cluster analysis is a multivariate statistical technique; here it was used to identify the most distinct subgroups of anglers based on their reasons for fishing.

Data

The data for this analysis was based on a sample of resident and nonresident license holders. A total of 2672 questionnaires were mailed in the summer and fall of 1986. A total of 2171 completed questionnaires were received or a response rate of 81 percent. This is a very high response rate for a mail survey and indicates that trout anglers have a keen interest in Montana fisheries.

Results

The cluster analysis is reported in detail in Allen (1987). The cluster analysis showed that the most clearly defined subgroupings were with four angler types. The groups included two generalist types, an occasional angler group and a specialist group. Members of the specialist groups are twice as likely to be fly fishermen compared to the other three groups (60 percent versus 30 percent) and have higher income levels. Occasional fishermen are twice as likely to catch no fish as the other groups and fish one-third as much. The two generalist types differ mainly in that one is more oriented toward the outdoors and solitude while the other is more oriented toward the fishing itself.

Logit functions were estimated for each cluster (angler group) and separately for each river. In general the probability of a "yes" response was found to be significantly correlated to the standard economic demand variables (price (bid), income, quantity (number of trips and days fished per trip), measures of taste and preference (reasons for fishing, how much the angler prefers fishing to other activities, etc.) and measures of angler success (number of trout caught). In addition, the sign of the estimated coefficients were generally consistent with the economic theory of demand. For example, the higher the income level of the respondent, the more likely a "yes" response to a given bid level. The high significance level of the estimated parameters, the large number of significant variables and the theoretical consistency of the signs indicate the logit model provides a good specification for the dichotomous choice responses. In general, the river specific sample sizes were around 100 to 150 respondents. However, functions could not be estimated on several rivers due to limited samples.

The estimated net economic values varied dramatically across cluster group for the logit analysis. As one might expect, mean value per trip increases the more specialized and committed to the sport the angler is. For example, with respect to mean values for the current trip, the occasional user has a net value per trip of only $7.56, while the generalist groups are at $91.03 and $117.07 and the specialist group has a value of $170.28.

The open-ended CVM responses also show large differences across clusters. However, the open-ended CVM analysis was not particularly successful in that 40 to 45 percent of all respondents indicated a zero willingness to pay. It was found that many individuals who said they would pay "zero" on the open-ended CVM in fact responded "yes" when faced with a specific amount in the logit portion of the survey. One possible interpretation is that the open-ended CVM has not successfully elicited responses for a large subsample of survey respondents. This may be in part because of the difficulty of answering the open-ended question. Because of these problems, not much credibility can be placed on the open-ended estimates.

The logit estimates also varied considerably across rivers, from $58 per trip on the Bitterroot to $228 on the Madison. The mean net economic value per trip averaged across 17 rivers is $117. A limitation of the analysis is that on several rivers, the highest bid asked (generally $500) was not sufficiently high to identify the point where the probability of a "yes" response is driven down to near zero. This was especially a problem on the Big Hole, Beaverhead and Gallatin, where a high proportion of respondents were willing to pay even the highest bid asked. This problem was compounded in several cases by the limited sample size.

Logit values were also calculated for angler net willingness to pay for changes in fishery quality. One finding was that anglers were willing to pay significantly more for doubled chances of catching large trout on 60 percent of the sample rivers. By contrast, anglers were willing to pay significantly more for doubled catch on only around 15 percent of the rivers.

In order to validate the logit estimates, they were compared to results of a travel cost model of Montana stream fishing (Duffield, Brooks, and Loomis, 1987). The data base for the latter study was derived from a 1985 survey of Montana anglers. The travel cost model uses observations of travel distance (and costs) as a measure of price and actual observed recreation trips as a measure of quantity to statistically trace out a demand equation. The travel cost model estimate of net economic value per trip (for the same set of 17 rivers used in the logit analysis) is $122 based on angler reported travel costs. This is almost identical to the logit mean estimate of $127. There is also considerable agreement on site specific values in the two separate studies. The Pearson product-moment correlation coefficient for the sample of 17 rivers is .73; this indicates that the logit and travel cost model values for these sites are highly and positively correlated. Similarly, a relatively high value for the nonparametric Spearman's correlation coefficient (.73) indicates that the two methods tend to provide a consistent ranking of sites according to net value per trip.

It would appear that the consistency of site level results provide a measure of validation for both the travel cost model and the logit CVM results. The similarity of estimates is remarkable given the very different methods and the separate data bases employed.

The net economic values presented in this paper are the appropriate values to use in benefit/cost analysis or where economic efficiency decisions (i.e., forest planning) are being made. The values per trip can be converted to net present values that can be used in trade-off analysis with marketed resources, such as timber, coal or grazing. The net economic values presented here are limited to the direct use values associated with Montana stream fishing resources. Accordingly, these net economic values are an underestimate of the total value associated with this resource, since indirect values (existence, bequest and option uses) have not been estimated.

TABLE OF CONTENTS

Executive Summary i

Table of Contents v

List of Tables vi

Acknowledgements viii

I. INTRODUCTION 1

II. METHODOLOGY 2

- A. Definition of Economic Benefits 2
- B. Contingent Valuation Methods: Literature Review 3
- C. Validation of Benefit Estimates 6
- D. Dichotomous Choice Study Design 8
- E. Open-ended CVM Study Design 11
- F. Market Segmentation Study Design 12

III. DATA 13

IV. ESTIMATED EQUATIONS 13

- A. Complete Sample: Logit 13
- B. Complete Sample: Open-ended CVM 15
- C. Logit Equations by Cluster 16
- D. Open CVM Equations by Cluster 17
- E. Logit Equations by River 17
- F. Open CVM Equations by River 18

V. BENEFIT ESTIMATES 19

- A. Logit: Complete Sample 19
- B. Complete Sample Results for Open CVM 20
- C. Logit Estimates by Cluster 22
- D. Open CVM by Cluster 23
- E. Logit Results by River 24
- F. Open CVM by River 26

VI. COMPARISON OF CVM AND TCM ESTIMATES BY RIVER 28

VII. SUGGESTIONS FOR FUTURE RESEARCH 32

REFERENCES 34

APPENDIX A: SURVEY QUESTIONNAIRE

LIST OF TABLES

Table 1. Response Rate on Angler Preference Survey
Table 2. Multivariate Logit Equations Complete Sample
Table 3. Open CVM Equations for the Full Sample
Table 4. Open CVM Equations for the Full Sample Including Starting Bids
Table 5. Summary of Cluster Type Characteristics
Table 6. Multivariate Logit Equations for Current Conditions by Cluster
Table 7. Multivariate Logit Equations for Large Trout by Cluster
Table 8. Multivariate Logit Equations for Doubled Catch by Cluster
Table 9. Open CVM Equations by Cluster Grouping: Current Conditions
Table 10. Open CVM Equations by Cluster Grouping: Large Trout
Table 11. Open CVM Equations by Cluster Grouping: Doubled Catch
Table 12. Multivariate Logit Equations for Current Conditions by River
Table 13. Multivariate Logit Equations for Large Trout by River
Table 14. Multivariate Logit Equations for Doubled Catch by River
Table 15. Sample Size for Logit by River
Table 16. Open CVM Equations by River: Current Conditions
Table 17. Open CVM Equations by River: Large Trout
Table 18. Open CVM Equations by River: Doubled Catch
Table 19. Logit Estimated Net Economic Value per Trip Complete Sample
Table 20. Summary of Open CVM Statistics for Complete Sample
Table 21. Influence of Selected Subsamples on Open CVM Mean Willingness to Pay
Table 22. Logit by Cluster Net Economic Values per Trip
Table 23. Open Ended CVM Mean Bids by Cluster Complete Sample
Table 24. Open Ended CVM Mean Bids by Cluster Group Response Not Equal to Zero Excluded
Table 25. Open Ended CVM Mean Bids by Cluster Group: 0 < Response < 500
Table 26. Logit by River: Mean Values for Current Conditions
Table 27. Logit by River: Mean Values for Large Trout
Table 28. Logit by River: Mean Values for Doubled Catch
Table 29. Comparison of Bid Response by River for Logit Method
Table 30. Summary Comparison of Median Logit Bids by River
Table 31. Open Ended CVM Mean Bids by River
Table 32. Open Ended CVM Mean Bids by River: Response Equal to Zero Excluded (Summary)
Table 33. Open Ended CVM Mean Bids by River: Response Equal to Zero Excluded (Current Conditions)
Table 34. Open Ended CVM Mean Bids by River: Response Equal to Zero Excluded (Large Trout)
Table 35. Open Ended CVM Mean Bids by River: Response Equal to Zero Excluded (Double Catch)
Table 36. Open Ended CVM Mean Bids by River: 0 < Response < 500 (Summary)

Table 37. Open Ended CVM Mean Bids by River: 0 < Response < 500 (Current Conditions)
Table 38. Open Ended CVM Mean Bids by River: 0 < Response < 500 (Large Trout)
Table 39. Open Ended CVM Mean Bids by River: 0 < Response < 500 (Double Catch)
Table 40. Comparison of Bid Responses by River for Open CVM Method
Table 41. Summary Comparison of Bid Question Response by River: Logit and Open CVM
Table 42. Comparison of Bid Question Responses by River: Logit and Open CVM
Table 43. Montana Trout Stream Fishing: Means and Standard Deviations for Alternative TCM and CVM Measures of Net Economic Value per Trip (by River)
Table 44. Listing of Net Economic Value per Trip for Ten Methodologies and Measures (by River)
Table 45. Comparative Analysis Across Angler Studies Correlation Coefficient: Pearsons and Spearmans
Table 46. Sample Size and Comparison of TCM and CVM: Net Economic Value Per Trip
Table 47. Summary Correlation Coefficients for CVM and TCM by CVM Subsample
Table 48. Montana Trout Stream Fishing: CVM and TCM Bivariate Regressions

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I. INTRODUCTION

This report provides contingent valuation method estimates of net willingness to pay for trout fishing on nineteen Montana rivers. The study is based on the Angler Preference Survey administered by the Montana Department of Fish, Wildlife and Parks in summer and fall of 1986. A more complete description and analysis of survey findings with respect to angler characteristics, preferences, attitudes and behavior is provided in a companion paper by Allen (1987).

The major goals of the overall study are as follows:

1. To estimate net economic value of cold water stream fishing in Montana by subgroups of trout anglers and by river. This information can be used to inform fishery management and resource allocation decisions where tradeoffs with marketed commodities must be evaluated.

2. To learn more about Montana trout fishermen, including demographic characteristics, reasons for fishing and angler preferences and beliefs. This information can serve as baseline data for future studies.

3. To learn about anglers' perceptions of possible recreational conflicts or management problems and to measure their attitudes toward potential river and fisheries management programs. Fisheries managers can use this information to review existing management policies.

4. To estimate the net economic value associated with changes in fishery quality. Specifically, to estimate angler net willingness to pay for improved chances of catching larger trout and more trout.

5. To contribute to the development of methods used by resource professionals in the analysis of recreation behavior.

The main focus of this paper is on estimating the economic values associated with trout fishing in Montana. A key issue that we have addressed is the problem of market definition. Economic theory suggests that markets are defined for relatively homogeneous commodities. In attempting to measure the value of a recreational activity such as fishing, it is therefore necessary to first define the recreation experience. Fishing, or even more narrowly trout fishing on Montana rivers, is an activity with many different styles, settings, technologies and purposes. Because of this, the fishing experience varies considerably from one angler to the next. While fishing is subjective and personally experienced, research suggests several ways to develope a reasonable number of angler "types", people who are seeking the same types of experiences through fishing (Adams, 1979). It makes sense to estimate dollar values not just for fishing, but for specific types of fishing experiences found on Montana trout streams. From the standpoint of economic theory, these types of fishing experience define relatively homogeneous commodities in the market for outdoor recreation.

Hobson Bryan's (1979) research on angler specialization paved the way for this area of research. By observing and interviewing anglers on several trout streams in Montana and Idaho, Bryan developed a typology of anglers, ranging from the occasional angler to the technique and setting specialists who do nothing but fly fish. We have identified four angler types using cluster analysis. The basic data utilized is angler response to questions listing seventeen possible reasons for choosing the river fished on the most recent trip. The detailed preference information developed in the survey was also useful in providing explanatory variables in the economic models.

Two basic methods were used to estimate net economic values: open-ended and dichotomous choice contingent valuation methods (CVM). The latter uses survey techniques to ask people about the values they would place on nonmarket commodities if markets did exist. In other words, individuals are asked to value resources or experiences contingent on the creation of a market or other means of payment such as taxes or fees. The other major approach to estimating values associated with outdoor recreation is the travel cost model (TCM). As described in a previous report (Duffield, Loomis, and Brooks, 1987), the latter method has also been applied to Montana cold water stream and lake fishing. A major issue in the economics of outdoor recreation is whether any of these nonmarket benefit estimation methodologies provide a good approximation to market values. This study provides a side-by-side application of the models for purposes of validation.

The next section of this paper provides a brief literature review and a description of the CVM and cluster analysis methodologies. The following two sections describe the estimated models and the resulting net willingness to pay. The last section provides a comparison of the CVM and TCM results.

II. METHODOLOGY

A. Definition of Economic Benefits

Economic benefits are defined here as net willingness to pay. The latter is the net difference between the maximum an individual would be willing to pay before foregoing the use of a resource or commodity and the amount they must actually pay. Net willingness to pay is the appropriate measure in applied welfare economics (Just, Hueth and Schmitz, 1982). Many federal agencies are required by the U.S. Water Resources Council Principles and Guidelines (1983) to use the net willingness to pay concept to measure the economic value of both marketed goods (e.g., agricultural commodities, hydropower, etc.) and non-marketed resources (e.g., recreation) in benefit cost analysis or evaluation of federal actions. When performing natural resource damage assessments, the U.S. Department of Interior regulations require that the calculation of economic values gained (or lost) to society by measured in terms of net willingness to pay (U.S. Department of Interior, 1986).

In general, use of the net willingness to pay measure provides a theoretically consistent measure of the allocative impacts of policy choices. The recreational value estimates developed here can be used to evaluate tradeoffs with marketed commodities and to identify the net effect of a given resource allocation decision. Specific applications might include evaluating a proposed hydroelectric project. The implicit criteria is economic efficiency: maximize the net present value of a given resource from the standpoint of the whole society.

Net willingness to pay is distinct from recreation expenditures. The latter information is useful for defining the relationship between the recreation activity and the local or regional economy. For example, one might estimate the number of jobs or the personal income generated by a given recreation resource. This type of regional economic analysis may also be relevant for policy decisions, but only if one is willing to deviate from strict economic efficiency and include distributive or other considerations. Such an analysis is beyond the scope of this project.

B. Contingent Valuation Methods: Literature Review

The two most widely used methods for estimating net willingness to pay for outdoor recreation are CVM and TCM. These are also the two general methods recommended by the U.S. Water Resources Council for valuing recreation in federal cost benefit analysis. The travel cost approach estimates demand functions for a given site from observed visit rates corresponding to the supply prices (travel costs) from origins surrounding the site. A regional TCM application to Montana fisheries is described elsewhere (Duffield, Loomis and Brooks, 1987).

In the CVM approach individuals are directly surveyed as to their willingness to pay for the services of a given resource contingent on the existence of a hypothetical market situation. This is a very flexible technique and has been applied to a wide range of environmental and resource issues including air and water quality changes, scenic beauty, and wildlife (Cummings, Brookshire and Schulze, 1986). The only limitation of the method is the ability of the researcher to frame understandable questions and the willingness and ability of the respondent to accurately value the good or service.

Bishop and Heberlein (1985) have described six key methodological choices in a CVM application: 1) target population, 2) product definition, 3) payment vehicle, 4) question format, 5) method of analysis, and 6) supplemental data. With respect to population, the choice generally hinges on what types of values are being addressed. TCM by necessity and often most CVM focus on the values associated with direct use; accordingly the target population is direct users (eg. hunters, fishermen etc.). However, there is a considerable literature on indirect or nonuser values such as option, existence and bequest values (Fisher and Raucher, 1984). Estimating the latter typically implies a regional population addressed through a household survey (for example, Sutherland, 1982).

Product definition and payment vehicle are two key features of the hypothetical market. The resource or service at issue must be clearly described to the individual. This may be difficult for valuing changed conditions, such as the specific physical characteristics of a proposed hydropower installation (Duffield, 1984) or visibility impacts of a coal-fired plant (Rowe, D'Arge and Brookshire, 1980). Visual aids such as photos and charts have been used (Desvousges, Smith and McGivney, 1983). A problem is that the specific information given the individual can bias the response. A general approach is to vary the level of information and test for benefit sensitivity (Brookshire, 1976).

Just as for the product definition, it is generally agreed that a payment vehicle must be specified for the respondent. Mitchell and Carson (1981) suggest two criteria for an appropriate vehicle: realism and neutrality. Taxes or site fees may be means of payment that could be realistically employed for public resource use. However, responses to such vehicles may be more influenced by dissatisfaction with high taxes or aversion to fee fishing (for example) than by the value placed on the resource.
A vehicle that has been used successfully for hunting studies is an increase in trip expenses. Hammack and Brown (1974) used this approach in an innovative study of waterfowl hunting. As Bishop and Heberlein (1985) note, this is an appealing vehicle for such studies since respondents are familiar with paying expenses and expenses appear relatively neutral compared with other vehicles such as hunting fees.

The major methodological choice in a CVM study is the question format or value elicitation procedure. The latter also usually implies the type of analysis that will be undertaken. There are numerous variations, but four general approaches for asking CVM questions can be identified: open-ended questions, bidding games, dichotomous-choice questions, and contingent-ranking techniques. It is beyond the scope of this paper to review these methods in detail (for a recent review see Cummings, Brookshire and Schulze, 1986); however, the key features of each will be briefly described.

The open-ended is the simplest approach: respondents are asked their maximum willingness to pay for use of the given resource. This approach can be utilized in a mail survey and is therefore low cost. Interpretation is also fairly straightforward, requiring only the calculation of the mean offer amount. One difficulty can be in interpreting extreme values. For example, responses of "zero" may indicate a protest response against the payment vehicle or even against the idea that a given resource has a finite value. Generally follow-up questions are included that attempt to identify the reasons for a zero response. Similarly, it is often not clear what credibility can be attached to extremely high values. In general, the limitation of this approach is that respondents may not have sufficient information or stimulation to fully consider the value they place on the resource.

The most widely used alternative to the open-ended format is a bidding game, where interviewers ask the respondent for a yes or no response to a specific bid amount. If the respondent is willing to pay, for example, $10, the bid is raised in increments until the maximum willingness to pay is determined. Stoll (1983) argues that such an iterative approach is necessary to force individuals to engage themselves in the hypothetical market and continuously reconsider their willingness to pay. There is some disagreement in the literature as to whether the two approaches in fact yield consistently different results. Cummings, Brookshire and Schulze (1986) conclude that open-ended results are generally lower. However, Bishop et al (1984) compared open-ended questions and bidding games and found no significant difference. There are two major limitations to the bidding game approach. It is costly in that it requires face to face or telephone interviews. Secondly, many studies have shown a positive correlation between the initial (and arbitrary) bid and the final maximum bid. Empirical evidence of this starting point bias has been presented by Mitchell and Carson (1981), Duffield (1984), and Boyle, Bishop and Welsh (1985).

The dichotomous choice approach combines some of the better features of both open-ended and bidding. In dichotomous choice, the individual is faced with a single specific dollar bid and (like bidding games) response is a simple market-like yes or no. The dollar bid amount is systematically varied across respondents. Since the format is non-iterative (like the open-ended), it is amenable to mail survey and is therefore relatively low cost. This approach is relatively new, but has been successfully applied to valuation of hunting permits (Bishop and Heberlein, 1979), boating and scenic beauty (Boyle and Bishop, 1984), reservoir recreation (Sellar, Chavas and Stoll, 1985) and beach recreation (Bishop and Boyle, 1985). The major disadvantage of dichotomous choice is that analysis is more complex. This method exploits some of the considerable advancement in methods for modeling discrete choice over the last decade (Amemiya, 1981). Econometric models, such as the logit model are used to predict the probability of accepting an offer as a function of the stated bid and other socio-economic variables (as detailed below). There is some debate over the appropriate measure of central tendency (Hanneman, 1984 and Cameron, 1987) and issues regarding truncation and functional form (Bishop, Heberlein and Kealy , 1983; Boyle and Bishop, 1984; Boyle, 1985; Welsh, 1986; and Sellar, Chavas and Stoll, 1986).

A related method is contingent-ranking. Here the respondent ranks alternative combinations of environmental resources and monetary outlay. This method also requires the application of econometric techniques (Desvousges, Smith and McGivney, 1983).

As for any model of economic demand, the CVM estimates are generally improved and informed by including at least the conventional demand shifter variables such as income, price and availability of substitutes, and measures of tastes and preference. This is most critical for the dichotomous choice case, where incomplete specification could lead to omitted variable bias. As noted, for the open-ended and bidding game methods, analysis amounts to taking the mean of the maximum willingness to pay bids. However, for these two methods it is conventional practice to estimate "bid equations" that relate willingness to pay to demand shifter variables to help establish the credibility of responses.

As is obvious from this review of the CVM literature, there are advantages and disadvantages to each method. The open-ended and dichotomous choice methods were selected for this study. Major considerations were high interview cost and starting point bias associated with the bidding game format. In addition, recent research indicates that the open-ended and dichotomous choice models can provide fair approximations to market transactions (as developed in the following section). The specific methodologies employed (including the cluster analysis) are described in greater detail below.

C. Validation of Benefit Estimates

An important issue with respect to CVM estimates of net willingness to pay is whether they are accurate compared to real markets. This question has been addressed in several ways. From a theoretical standpoint, there is a considerable literature on the likelihood and direction of bias in subject CVM responses (for example, Brookshire, 1976). Rowe, D'Arge and Brookshire (1980) noted three main types of potential bias: strategic, information and hypothetical. The first of these could result from a respondent trying to strategically influence results to favor his preferred outcome. A number of studies have attempted to test for strategic behavior; the general finding is that it does not appear to be a problem (Thayer, 1981). However, as noted previously, researchers have noted sensitivity of benefit estimates to information provided the respondent and to starting bids (for a bidding game format). Hypothetical bias would imply a problem with the basic working assumption of CVM: that the hypothetical market institutions described to the respondent are not sufficiently real to generate valid responses. The presence or absence of the latter is not readily identified.

An alternative to attempting to measure and identify bias through internal consistency of subject responses is to compare CVM results to cash transactions. The earliest and best known of these experiments compare CVM responses (logit dichotomous choice) to the response to cash offers for goose hunting permits on a Wisconsin wildlife refuge. The average cash value accepted for a permit was $63 compare to the average market value of $101 for the corresponding CVM for willingness to accept. A CVM estimate for willingness to pay for permits was $21. A similar experiment was conducted for deer hunting (Welsh, 1986) in Wisconsin. In this case cash values for willingness to pay were $25 compared to $31 for the CVM. A number of other similar studies are reviewed by Anderson and Bishop (1986). The general conclusion from the comparison of simulated markets to CVM is that respondents attempt to give their true values. In some cases CVM appears to understate and in some cases overstate the market value. The degree of difference in general is small. Based on these results, it appears that one can have confidence that the willingness to pay responses derived from CVM methods are a fair approximation to the responses that would hold in real markets.

Another approach to validating CVM is to compare the results to those from other methods in a side by side application. For example, a study by Brookshire, Schulze, Thayer and D'Arge (1982) compared the results of a hedonic property value approach to a CVM survey. The comparison was between property value differentials as a function of air quality and CVM estimates of the value of a reduction in air pollution. The finding was that the stated WTP was significantly less than the property value differences. Most comparisons have been made to TCM estimates (Bishop and Heberlin, 1979; Desvousges et al, 1982; Duffield, 1984; and Seller, Stoll and Chavas, 1985). Some analysts have confidence in the TCM estimates since they are at least in part based on observed behavior. The general finding has been that TCM and CVM are in the same range. Often the comparison is sensitive to how time is valued in the TCM analysis.

In general, research on the validity of CVM methods is encouraging. Willingness to pay measures may not be perfectly accurate, but appear to be close to the values derived by other methods and in cash transaction experiments.

D. Dichotomous Choice Study Design

In dichotomous choice, individuals respond "yes" or "no" as to their willingness to pay a specific cash amount for a specified commodity or service (eg. $20 to fish on the Madison River). The proportion of respondents answering "yes" to a given bid level is utilized in a statistical model relating the probability of a "yes" to explanatory variables such as the bid amount, tastes, income, and other standard demand shifter type variables. The specific model is:

$$1) \quad P=F(x)$$

where P is the probability of buying, x is a vector representing explanatory variables, and F(.) is a cumulative probability distribution function. In the probit model, F(.) is the standard normal cumulative density function (cdf) and in the logit model F(.) is the cdf of a standard logistic variate, or:

$$2) \quad P=(1+e^{a+bx})^{-1}$$

where a is the constant term or intercept; b is the vector of regression coefficients. The equation to be estimated can be derived as:

$$3) \quad L=\ln(P/1-P)=a+bx$$

where L is the "logit" or log of the odds of a "yes". Hanemann (1984) has shown that the specific linear logit formulation in Equation 3) is consistent with the hypothesis of utility maximization. A log formulation is not consistent but has been widely used in the literature:

$$4) \quad L=\ln(P/1-P)=a+b\ln(x)$$

This formulation can of course be rewritten to make the vector of explanatory variables explicit:

$$5) \quad L = \ln(P/1-P) = a + b_1x_1 + b_2x_2 + \dots + b_nx_n$$

where the explanatory variables include the bid amount and typical demand shifter variables such as quantity (number of trips for the case at hand), income and measures of taste and preference. In a recent paper (1986), Sellar, Chavas and Stoll have shown that an inverse demand curve can be derived from 5) and have explored the implications of functional form for consistency with economic theory. Their basic finding is that a linear logit specification was found to be inappropriate by implying an upward sloping demand curve. Although other specifications may also be possible, a log-linear specification was found to be superior in terms of meeting the theoretical restrictions. Given these findings, we have chosen to estimate a logit model of the log-linear form as in equation 5).

For the demand function to be downward sloping with respect to quantity consumed, Sellar, Chavas and Stoll also show that the estimated coefficient on trips must be negative and have an absolute value less than one. (This restriction on empirical findings will be referred to below in the results section.)

Equation 5) is generally estimated with maximum likelihood techniques. That is the approach taken here; the Probit program in SPSS^X was used to estimate the logit model. (The probit model is not reported below; the logit is computationally more convenient and a subsample of cases showed very little difference in estimates between the two statistical models.)

Once the estimated model parameters are available, either the mathematical expectation (mean) of maximum willingness to pay or the median of the distribution (where the probability of acceptance equals .5) can be used as a measure of welfare surplus. The specifics of these calculations will be briefly discussed.

Note that the estimated equation 5) can be solved for P as in equation 2). The latter can be evaluated at the means of the untransformed independent variables to estimate a bivariate equation with the probability of acceptance (P) as a function of the bid amount (x_1). This function can easily be graphed with probability on the vertical axis and bid on the horizontal. At low bid amounts, the probability of acceptance is high and declines (asymptotically approaches zero) as the bid amount increases. The median is obtained by integrating the logit function from a bid value of 0 to some upper limit. Since the mean corresponds to the area under the two dimensional curve, it has the intuitive interpretation of probability times bid amount. This is of course consistent with the definition of a mathematical expectation or mean. Estimation of the median is simpler: the bivariate estimate of 5) is simply solved for P=.5. (Note that $\ln(P/1-P)$ evaluated at $P=.5$ is $\ln(1)$ or zero; accordingly the median is equal to the calculated intercept over the slope coefficient on bids.)

There is currently an unresolved debate in the economics literature over which of these measures of central tendency is most appropriate. Hanemann (1984) suggests that the median is more robust. However, in most applications results have been presented in terms of the mean (for example, Bishop and Heberlein, 1979 and Seller, Stoll and Chavas, 1985). It can be noted that in the use of other methodologies such as open-ended CVM and TCM, the mean is the reported estimate, not the median. Both the median and mean will be reported below. Cameron (1987) has recently developed an alternative model for interpreting qualitative response data where there is continuous information on the choice threshold (here, the bid level). It is beyond the scope of this study to provide an application here of Cameron's censored logistic regression approach. However, it can be noted that the medians presented below for the conventional logit model correspond to the means (and medians) in Cameron's approach.

It should be noted that there is no clear basis for choice of the upper limit of integration in the estimation of the mean. We have chosen to truncate the estimate at two alternative levels: 1) at the maximum bid utilized in the sample and 2) at the maximum bid for which a "yes" response is received. The argument for 1) is that extrapolating beyond the range of the sample data is inappropriate on statistical grounds. 2) is a more conservative choice and provides information on the sensitivity of the estimate to this methodological choice. It may be noted that truncation is not an issue if benefits are not sensitive to the upper limit. If benefits are sensitive, it may be an indication that the range of offer bids in the sample was not sufficiently high. In other words, one will generally want to have sufficient high bids to clearly establish the point at which probability of a "yes" goes to zero.

Three specific logit questions were developed for this study. One question addressed the willingness to pay for current conditions, and the other two willingness to pay to double the chances of catching larger trout and to double the overall catch respectively. A complete copy of the questionnaire is in Appendix A; the economics questions are in Section III. As a lead in to the CVM questions (following Hammack and Brown, 1974), respondents were asked what their total trip expenditures were for their most recent trip. They were also asked if the trip was worth more than they spent. The dichotomous choice CVM on current conditions follows as: "If YES, would you still have made the trip if your share of expenses had been (bid amount) more?" (yes/no response) The bid amount was randomly varied across questionnaires and ranged from $1 to $500 in 27 specific amounts (1,2,4,5,6,8,10,15,18,20,22,25,30,35,40,45,50,60,70,80, 100,150,200,250,300,400,500).

The phrasing of the second question is: "Imagine that everything about this last trip were the same except that your chances of catching a large trout was twice as great AND that your trip costs were (bid amount) more than your actual costs. Would you still have made the trip under these circumstances?" (yes, no response). The bid amounts used were the same as for the first question. The third question is identical except that respondents were asked to suppose that they caught "twice as many trout".

E. Open-ended CVM Study Design

The design and interpretation of the open-ended questions is more straightforward. Respondents are directly asked their maximum willingness to pay. The mean and median willingness to pay are directly estimated from the distribution of responses. The specific questions are again listed in Appendix A and pursue the same issues as the dichotomous choice. As an example, the open-ended CVM for current conditions (which follows the corresponding dichotomous choice question (Appendix A)) is: "What is the maximum increase in your actual trip cost you would have paid to fish the (name of specific river fished) instead of having to fish elsewhere?" _______________ Dollars

After the open CVM question, the following is asked to identify protest responses: "If your answer was zero, could you briefly explain why?" The questions on large trout and doubled catch are similar (Appendix A).

In order to establish the credibility of the open-ended responses, a bid equation of the following form is generally estimated:

6) $Y = A + BX$

where Y is the respondent bid, A is an intercept term, B is a vector of estimated parameters, and X is a vector of explanatory variables including the conventional demand shifter variables such as income and tastes and preference. When a quantity variable is included, 6) may be interpreted as an inverse demand function. The equation is estimated with OLS regression and the functional forms investigated can include linear or log-linear.

The key CVM methodological choices can be summarized as follows: target is the user population (intrinsic values are ignored in this study); the product is a fishing experience; the payment vehicle is trip expenses; question formats are dichotomous choice and open-ended.

F. Market Segmentation Study Design

As noted in the introduction, a central goal of this study is to identify specific angler subgroups and to investigate how economic values vary across experience or angler types. A theoretical basis for angler types has been developed by Bryan (1979). Both canonical analysis and cluster analysis have been previously applied to water-based recreation to define recreation subgroups (Ditton, Goodale and Johnsen,1975; Adams, 1979). Cluster analysis is utilized in this study. The cluster analysis methodology is described in the companion paper by Allen (1987) and will be briefly summarized here.

Included in the survey (Appendix A) is a list of 17 possible reasons for fishing a specific river on the angler's most recent trip. The reasons include "to catch large trout", "to catch many trout", "to be with my family", "to experience solitude", etc. The respondent is asked to rank the reasons on a four interval scale from "very important" to "not at all important". These responses indicate the types of experiences anglers were seeking. Although responses are for a specific river, they indicate the general type of experience the angler gets from fishing.

A cluster analysis package (SPSSx) can be used to identify subgroups of anglers based on the reasons for fishing. The analyst must select the desired number of clusters in running the statistical package. In choosing the cluster number, a consideration is that the smallest subgroup include sufficient size for economic analysis (at least 100). The main criteria is that the clusters make sense conceptually and that the subgroups of anglers defined are distinct. This is in part determined by examining cluster centers (or mean values) for each of the reason values and also the means of other descriptive socio-economic variables (such as income, age, residence, etc.) for the defined subgroups. Well-defined clusters will have distinct differences across both reasons for fishing (eg. large trout versus many trout, solitude versus family, etc.) and across demographic characteristics.

From the standpoint of the economic analysis, the key output of the cluster analysis is a cluster membership ID variable that is used to segment the Montana trout fishing market into subgroups of experience or angler types. The CVM analysis described above is then preformed for each of the market segment subsamples. The working hypothesis is that economic values will be significantly different across subgroup and consistent with the socio-economic and preference variables that characterize the experience types (eg. income, residence, age, etc.).

III. DATA

The sample frame was a list of residents and non-residents who purchased Montana fishing licenses and were contacted in Montana Department of Fish, Wildlife and Parks annual fishing pressure survey in 1985. The desired sample size was approximately 200 people for each of 20 rivers.

An adaption of Dillman's (1978) Total Design Method was used to conduct the mail survey. A questionnaire booklet (Appendix A), cover letter, and an addressed, stamped return envelope was mailed to the sample. A postcard reminder was sent one week later. Two weeks after that, a follow-up letter and second copy of the booklet was sent to people who had not responded. This method typically yields response rates of over 70 percent. A pretest indicted that the questionnaire, while lengthy and detailed, was clearly understood by respondents and that respondents would take the time to participate in the survey.

The available DFWP angler data did not allow us to meet the target sample size on many rivers. This was offset somewhat by the excellent rate of response, which averaged 81 percent across rivers. Table shows the number of questionnaires mailed and returned by river. The uniformly high response rates indicate not only that the survey methodology could be implemented, but that trout anglers have a keen interest in fisheries management issues.

An overview of the descriptive variables in the survey is provided in Allen (1987).

IV. ESTIMATED EQUATIONS

A. Complete Sample: Logit

The estimated logit equations for the complete sample (approximately 1750 observations with complete information) are presented in this section. The equations (corresponding to the general specification presented above as equation 5) are shown in Table 2. Included variables were all significant at the 90 percent level or better. It should be noted that the specification is log-linear as noted above. The log variable transformation is not shown explicitly in Table 2.

In almost every case the theoretically correct sign on the regression coefficient occurs. For example, coefficients on bid amount are consistently negative (higher bid price implies a lower probability of a yes response) and very precisely estimated. Similarly, INCOME is positive and significantly correlated to willingness to pay in all cases. The sign on the quantity variable (STRPSHM or separate trips from home to the given river destination) is consistently negative and meets the theoretical constraint suggested by Seller, Chavas and Stoll (absolute value less than one). The coefficient on DYSFSHED is consistently positive (the longer the trip, the more probable a yes response). Similarly, the longer the angler fished per day (HRSDAY), the more likely a yes becomes.

Measures of angler preferences were also successful: the less the respondent liked to fish (COMPARE) and the worse the given river compared to other rivers (TCOMPARE), the less probable a yes response becomes (negative correlation). Several of the reasons for fishing were also used for preference measures: to catch many trout (REASON03) and to catch large trout (REASON06). These variables were significant only for one case: equation 9) for double catch of large trout. In this equation REASON06 is significant and of the right sign (the less important this reason, the less likely a yes response).

Measures of fishing success were the only variables with unexpected signs. For the current conditions equation 7), the sign on number of large trout caught (LRGCOT) is positive as expected. However, one would expect that the sign might have the opposite value for doubling the catch of large trout (people who catch fewer large fish would pay more to catch some). In fact, the sign is positive in both equation 8) and 9) for both LRGCOT and TROUTCOT (trout catch). This suggests that anglers who are already catching relatively more trout and more large trout are also most willing to pay to increase their catches.

It was also found that if the river was not the only river fished on the given trip (RVRMAIN) and if the trip had more purposes (REASON) than fishing (visiting relatives, business, etc.), a yes was more probable. This is an interesting result in that an a priori hypothesis is not obvious. Since the length of time actually spent on the river has been corrected for (HRSDAY AND DYSFSHED) there is no obvious reason to expect that fishing experienced as part of a multipurpose or multidestination trip would be valued more or less highly. The result is potentially important with respect to comparison of CVM and TCM estimates. Where possible, TCM models are always estimated on a subsample of single destination and single purpose trips in order that trip costs can be interpreted as the supply price for the given experience. If in fact anglers on multiple-destination and multiple purpose trips value a comparable fishing experience more highly than the TCM subsample, one would expect TCM estimates to generally fall below CVM. In addition, such a result would suggest that one can conservatively apply TCM mean estimates to the entire direct user sample in developing total site values. Further analysis may indicate other underlying reasons for this correlation; for example, typically multiple-destination and multiple-purpose trips will be more likely for non-residents traveling from longer distances.

In general the high significance level of the estimated parameters, the large number of significant variables, and the theoretical consistency of the signs indicates the logit model provides a good specification for the dichotomous choice responses.

The goodness of fit statistic available on the SPSSx probit package is the Pearson chi-square. The latter is only calculated for grouped data. A rule of thumb is that the chi-square is not reliable if more than 20 percent of the cells have expected frequencies of less than 5. Given this limitation, only a bivariate case (with data grouped on the bid variable) can be reliably interpreted. For the bivariate case, the chi-square statistics were uniformly quite large, indicating that the null hypothesis (that the sampled distribution matched the theoretical logit distribution) should be rejected. It is not clear to what extent the fit is improved in the multivariate model reported here. In any case, the complete sample aggregates across very different rivers and angler subgroups. It may be that attempting to develop a single equation model could require river specific dummy variables and angler cluster membership. As will be shown below, when the data is disaggregated by river and cluster, the chi-square statistic in many cases indicates a good fit to the data.

B. Complete Sample: Open-ended CVM

The bid equations for the complete sample open-ended CVM are shown in Table 3. The specification is log-linear and again the log transformation is not made explicit. Because the log model excludes zero bid observations, the overall sample varies from 880 to 965 for the three equations. The overall explanatory power of the model is fair (adjusted R square of .33 to .36). As for the logit model, a large number of independent variables were highly significantly correlated to the bid amounts and the signs were generally of the correct sign. All of the variables that were significant in the logit model were significant in the open CVM including quantity measures and income. In addition, several other variables came in significant in one or more equation.

The measure of days per year the angler fished (DYSFSHYR) was positively correlated to the bid amount. Older anglers (AGE) and those with greater experience on a given river (YRSFSHRV) stated generally lower bid amounts. Interestingly, those with higher total catches were again willing to pay more, but those who kept more trout (TROUTKPT) were willing to pay relatively less. This is an interesting result and is consistent with results from the cluster analysis. As will be noted below, the subgroup of anglers most interested in catching fish for food had average willingness to pay much lower than other subgroups.

These results indicate that the open CVM bids are generally consistent with economic theory and can be in part explained by conventional demand function variables. Because of the sequence of questions in the survey instrument (with open CVM following the dichotomous choice), a second set of equations (Table 4) were estimated that included the logit bid. The question is whether if the logit bid is relatively high (say $200 rather than $20), the respondents open CVM is also relatively high. In other words, the logit bid may be causing something like starting bid bias in a bidding game format.

The basic finding is that open CVM bids are significantly and positively correlated to the random logit bids. For example in the equation for current conditions (13), the coefficient on the corresponding logit offer bid (DOLAMT) is +.106477. Since the specification is log-linear, this parameter represents the elasticity of the open CVM bid with respect to the logit bid. In other words, a one percent increase in the logit offer bid results in a .11 percent increase in the open CVM bid. As a specific example, if the logit bid is $300 instead of $10, on average the open CVM will be 44 percent higher. While significant, it can be noted that the elasticity on most other variables is much higher (for example, income is .28 and days fished is .47).

One implication of this finding is that if both open CVM and other question formats are used on the same survey instrument, it may be better to have them in separate sections rather than grouped by issue (eg. larger trout). On the other hand, grouping undoubtedly makes the survey less burdensome for the respondent.

C. Logit Equations by Cluster

The cluster analysis is reported in detail in Allen (1987). However, the basic cluster types will be briefly characterized here. The cluster analysis showed that the most clearly defined subgroupings were with four angler types. Based on the cluster type characteristics, the groups include two generalist types (resident and non-resident), an occasionalist group and a specialist group. A listing of the groups and summary characteristics are provided in Table 5. As an example, the specialist group is twice as likely to be fly fishermen as the other three groups (60 percent versus around 30 percent) and have higher income levels (68 percent of all respondents with incomes over 100,000 are in this group). Occasional fishermen are twice as likely to catch no fish as the other groups and fish one-third as much. In general, the group characteristics suggest fairly well defined groupings as developed in detail in Allen (1987). Interestingly, clustering on reasons for fishing resulted in a grouping of angler types that is quite consistent with Bryan's (1979) theoretical model.

Equations for each of the clusters and for the three bidding questions are presented in Tables 6, 7 and 8. As for the complete sample, variables included are significant at the 90 percent level or better. In general, all variables except catch again have the expected sign. In all cases where it is significant, the quantity variable (STRPSHM) satisfies the theoretical constraints. Perhaps due to smaller sample size, fewer variables were found to be significant (five to eight) compared to the complete sample where nine to eleven variables were significantly correlated to the probability of a yes response.

Bivariate equations were also estimated in order to examine the goodness of fit (chi-square statistic). The null hypothesis was rejected in six of twelve cases. However, in several of the estimates the chi-square was very small and had a probability as high as .50 to .90, indicating an excellent fit to the data. In at least several of the cases where the null hypothesis is rejected, the rule of thumb for cell size is exceeded. Again, it is also unclear how much the multivariate model improves the fit. It would be useful to develop additional goodness of fit information for model evaluation.

Based on the t-statistics for the estimated coefficients, number of significant variables, and theoretically consistent signs, the logit cluster estimates compare quite favorably with other dichotomous choice models reported in the economics literature.

D. Open CVM Equations by Cluster

Open CVM bid equations by cluster are summarized in Tables 9, 10, and 11. The results are comparable to those for the complete sample in terms of significance level, signs and overall explanatory power of the models. It is interesting to note that generally the models for the generalist and specialist subgroups have twice the explanatory power of the occasional user subgroup response. This may indicate that more committed anglers are better able to value their experience.

E. Logit Equations by River

The estimated logit equations by river are listed in Table 12 for the current conditions bid question. The large trout and doubled catch bid question equations are listed in Tables 13 and 14 respectively. The estimates are similar to those for cluster and complete samples. Generally fewer variables are included in these estimates (two to five significant variables).

The sample sizes for the logit estimates by river are listed in Table 15. Two of the rivers, Upper Clark Fork and South Fork of the Flathead, had insufficient observations (29 and 11 responses respectively) for the maximum likelihood estimate to converge. The next smallest samples were for the Smith (44 to 46 observations), Boulder (67 to 69), Kootenai (70 to 73) and Rock Creek (72 to 78). All other rivers had sample sizes of around 100 to 150. It should be noted that the sample sizes by river vary across bid equation depending on the specific variables included and the number of missing observations for each of those variables. These sample sizes are comparable to those reported in the literature. For example, Sellar, Stoll and Chavas (1985) report logit estimates for four sites with samples of 70,74,47 and 15. No variables were found to be significant for their smallest sample and one to two significant (95 percent level) correlations were found for the larger samples. Bishop and Heberlein (1979) reported samples of around 200 and one significant variable.

The sign of the included variables reported in Tables 12, 13 and 14 generally correspond to the theoretical expectation. All bid variables are negatively correlated with the probability of a yes response and are highly significant. Where significant, the coefficient on quantity (STRPSHM) is in every case negative and less than one in absolute value. In short, the logit estimates compare favorably with others reported in the literature.

In order to obtain a goodness of fit statistic for the river specific estimates, bivariate (only one independent variable, the bid amount) equations were also estimated. The chi-square statistic is used to test the hypothesis that the observed distribution (of yes responses) matches the theoretical logit distribution. The calculated chi-square was found to be greater than the critical value (5 percent level) for only eight of the total 51 river specific equations. In other words, in most cases the bivariate logit model appears to provide a good fit to the data at the river specific level. However, because of the relatively small river-specific samples, the chi-square calculations typically include a large number of cells with less than 5 expected observations. In general the chi-square is not reliable if there are a large number of cells with few observations. All of the eight cases where the null hypothesis is rejected have a number of cells with less than five responses.

F. Open CVM Equations by River

Open CVM equations by river are reported in Tables 16,17 and 18. The functional form for all equations is log linear; the log transformation is, however, not shown explicitly in the variable listing. Because the log transformation is undefined for values of zero and because a large share of open CVM bid responses were zero, the number of observations reported by river is somewhat lower than for the logit model. In general the results of these bid equations by river are similar to those for the complete and cluster samples. The bid equations show moderate to high explanatory power and the significant variables generally have the theoretically correct signs. These results indicate that the non-zero open CVM responses are generally consistent with economic theory.

V. BENEFIT ESTIMATES

A. Logit: Complete Sample

Net economic values per trip based on the complete sample logit estimate are summarized in Table 19. The mean value for current conditions is $90.74 based on a sample of 1751 responses. This estimate is comparable to the net value per trip based on a regional travel cost model as reported in Duffield, Loomis and Brooks (1987). The latter average value per trip based on actual trips (Gum and Martin approach) is $54 for standard cost and $116 for reported travel costs. A more complete comparison of values for different methodologies is provided in section VI. below.

Complete sample logit mean values for doubling catch of large trout and doubling trout catch are somewhat higher than the $90 mean for current conditions: $101.77 and 97.52 respectively. Because these estimates are based on the multivariate logit equations reported above, a confidence interval estimate is not readily available. The upper limit of integration for the means reported here is $500, which is the maximum observed "yes" response and also the maximum bid asked.

Table 19 also provides an estimate of median logit values. The current condition median per trip is $24.51. The median value for doubled chances of a large trout is considerably higher: $48.84. The doubled catch median is also higher: $36.07.

For the complete sample, the mean and median have divergent findings with respect to the importance of doubled catch and large trout. The mean shows little net increased willingness to pay, while the median shows nearly doubled. Both measures show that doubling catch of large trout is more valued than doubling overall catch. The mean is probably the preferred measure since it incorporates the values associated with individuals in the high end of the distribution and corresponds to the theoretical measures used in other methodologies such as travel cost.

As will be shown below, logit estimates have also been successfully estimated when the data base is disaggregated by river and by cluster. The best overall estimates for the sample may be obtained by averaging over the results by river (to avoid aggregation error). However, the preceding results for the complete sample are included here to provide additional perspective on the analysis.

B. Complete Sample Results for Open CVM

Table 20 provides a summary of the descriptive statistics for the open CVM bid responses. As may be recalled, open CVM net values per trip are simply the mean of the bid response. The mean for current conditions, large trout and doubled catch questions are not significantly different: \$28.54, \$28.82 and \$26.64 respectively.

The most striking feature of the open CVM responses is the high proportion of zero responses. Approximately 40 to 45 percent of all respondents indicated that they valued the trip or changed conditions at zero (Table 20). As will be recalled, the only analytical issue with respect to open CVM is whether all extreme bid values should be included (specifically zeros and very high bids). The results in Table 20 exclude zero bids that were found, by the follow-up question on why the bid was zero (Appendix A), to be protest responses. The protest question responses were coded as shown in Appendix B. The approach taken here was to exclude the responses coded 3) "I pay taxes for use of public resources", 4) "Opposed to fee fishing" and 5) "question doesn't make sense/ I don't understand". The zero responses for other reasons appear to indicate that the individual participated in the question and had reasons for a zero response consistent with economic behavior. For example response 1) "could not afford additional cost" indicates an income constraint, etc. The total number of excluded zero responses is quite small. For the current conditions question, for example, only 72 responses were coded as 3, 4 or 5. This is approximately 7 percent of the 970 some zero responses.

At the high end of the bid range, each question had one response coded "9999". This response is excluded in Table 20. The highest remaining bids were \$2000 to \$2500 as shown. The other statistics provided in Table 20 give further information on the shape of the distribution: the large and positive kurtosis statistic indicates that the distribution is more peaked than a normal (bell-shaped) distribution. The peak in this case is at zero, which is also the mode of the distribution. The large and positive skewness statistic indicates that values cluster at the left side of the distribution (zero) with a long tail of extreme values to the right.

The main question with respect to the open CVM is whether all of the zero responses (even after excluding the obvious protest responses) are really valid. As may be recalled from the literature review, some analysts question whether a simple open-ended question will engage the respondent sufficiently to get a valid response. In this case it was possible to test for consistency with the logit responses. A cross-tabulation routine was run on the data to compare logit responses by individuals who bid "zero" on the open CVM versus the non-zero open CVM subsample. It was found that many individuals who said they would pay "zero" on the open CVM in fact responded "yes" when faced with a specific amount in the logit portion of the survey. Specifically, for the current conditions question, there were a total of 869 in the zero open CVM response group with sufficient information to be included in the logit sample. Of these, 385 or 44 percent responded "yes" to a nonzero logit bid. For example, 23 of 23 asked if they would pay $1 indicated yes on the logit question. Obviously, the responses for a very large portion of the sample are inconsistent across the two questionnaire types. One possible interpretation is that the open CVM has not successfully elicited responses for a large subsample of the survey respondents. This would imply that many of the zero responses indicate nonparticipation. This is perhaps not too surprising given how much more difficult it is to respond to an open-ended question ("what is the maximum you would be willing to pay"...etc.) compared to responding to a close-ended "would you be willing to pay an additional $10".

Another perspective on the high share of zero responses in the open CVM is obtained by examining the responses to very low logit bids. The "yes" response rate for the lowest fixed logit bid amounts ($1 and $2) averages 90 percent for all three logit questions combined (380 yes out of 423 bids).

Given the logit findings and the inconsistency of the zero open CVM responses, means for several different subsamples of the open CVM responses were calculated as shown in Table 21. One assumption might be that a zero response is unrealistic and that all zeros should be excluded. The result of this approach is that means approximately double to $46 to $52 per trip (Table 21). Sensitivity of the means to excluding the very highest bids was also explored. For example, if the nine bids over 500 are also excluded (in addition to zeros) for the current condition bid, the mean drops from $52 to $42. The basic finding here is that open CVM bid means are sensitive to exclusion of extreme values.

Also reported in Table 21 is the mean value for the subsample that would be used in a travel cost model. The latter is defined by including single destination and single purpose trips and is about half the complete sample (956 of 2183 observations for current conditions). The single destination-single purpose mean for current conditions is $23.59 which is significantly lower than the comparable full sample mean of $32.20. This is an interesting result with respect to interpreting the comparison of TCM and CVM models. It appears that the multi-destination and multi-purpose trip groups include a large fraction of non-residents. The latter group, other things equal (income, etc.) have a higher willingness to pay.

The open CVM means show no significant difference across bid questions. This result holds for all subsamples shown in Table 21. In short, the complete sample open CVM results indicate that anglers are not willing to pay for improved fishing with respect to larger or more trout. As noted previously, a caveat here is that the complete sample is included for purposes of perspective. Since the bid questions are asked for specific (and quite different) rivers, greater weight should be placed on the interpretation of the river specific results.

C. Logit Estimates by Cluster

Net economic values by angler user group are reported in Table 22. The most significant finding is that both mean and median values vary considerably across user group. As one might expect, net economic value per trip increases the more specialized and committed to the sport the angler is. For example, with respect to mean values for the current trip, the occasional user has a net value per trip of only $7.56, while the generalist groups are at $91.03 and $117.07 and the specialist group (no. 4) has a value of $170.28. A similar range is reflected in the median values.

It is interesting to note that only the occasional user group has a very large increased willingness to pay for doubled catch of large trout and doubled overall catch. Occasional users are willing to pay $7.56 for the current trip but $67.51 for doubled chances of a large trout and $45.26 for doubled overall catch. None of the other user groups show a large difference between the three bid questions based on means. In fact, the direction of difference for specialist group and generalist group no.2 is opposite of what one would expect. The median values, however, show the opposite result. All user groups have considerably higher willingness to pay for increased catch of large trout. Only the occasional user group also is willing to pay considerably more for doubled overall catch.

The mean and median results vary across the bid questions because of differences in the shapes of the logit distributions. For example, the mean values for current conditions and large trout bids are nearly identical for the specialist user group ($170 and $167 respectively). This indicates that the total area under the two logit distributions are about the same. However, the median for the large trout bid is somewhat higher for the specialists: $106 versus $72 for current conditions. This indicates that there is a higher probability of a yes response for bids to the 100 dollar range for large trout compared to current conditions. However, at even higher bid levels the probability of a yes drops off more rapidly for the large trout question. In other words, specialists are relatively more willing to respond yes to high bid amounts for current conditions. The shape of these distributions is indicated by the intercept and slope parameters shown previously in Table 6. For example, the coefficient on the specialist group current conditions equation for the bid variable is -.74 compared to -1.36 for large trout. As the bid value rises, the probability of a yes drops off much faster for the large trout question.

D. Open CVM by Cluster

Results of the open CVM bid equation by cluster are summarized in Tables 23, 24, and 25 for the complete sample, for the subsample with zero bids excluded and for the subsample of bids greater than zero and less than or equal to 500, respectively. As for the logit estimates, mean values again vary across clusters, with the two generalist groups having similar bid values, the occasional users very low mean bids, and the specialist group relatively high bids. For example, for current conditions the generalist bids are not significantly different ($29.03 and $28.33 for clusters 1 and 2 respectively). The occasional user group mean bid is $9.48 and the specialist bid $40.14.

Unlike the logit results, however, there is very little difference across bid questions for a given cluster. For example, even the occasional user group (which had very large differences across bid questions in the logit analysis (Table 22)) has almost identical mean bids across questions: $9.48, $9.44 and $8.44 for the current conditions, large trout and doubled catch questions respectively.

As one would expect, when all zero bids are excluded the means are approximately doubled (Table 24). However, cluster responses still do not vary across bid question. This same result holds when bids over $500 are also excluded (Table 25). When the extremely high bids are excluded, it may be noted that the estimated standard error declines noticeably (indicating that the means are more precisely estimated). For the most restrictive subsample (Table 25), it is interesting to note that the two generalist categories are not significantly different on mean bids for current conditions. However, for large trout and for doubled trout catch cluster no. 2 has a significantly higher mean bid. For the most restrictive subsample, the difference between the specialist and generalist groups is most pronounced, with the specialist mean bid being approximately double that of the average generalist bid. This is similar to the relative values derived in the logit analysis.

While there is some consistency between the logit and open CVM bid results, there are also some significant differences. Given the very high number of zero bid responses to the open CVM questions, greater credibility may be placed on the logit results.

E. Logit Results by River

Logit bid results by river are summarized in Tables 26, 27 and 28 for the three bid questions. Two different mean bid estimates (net value per trip) are displayed for each question. One estimate is based on truncation of the logit function integration at the highest bid for which a "yes" response is obtained. This varies from $500 to $250 as may be noted (Table 26). The other estimate is based on a truncation at $500 for all rivers; the latter is the largest bid value used in the sample. Four of the rivers had a yes response to $500 and accordingly have only one estimate.

For the truncation at the highest "yes" bid, mean values vary from $43 for the Bitterroot to $218 for the Big Hole (and $204 for the Madison). For the upper limit of $500, values vary from $59 on the Bitterroot to $228 on the Madison. As will be developed in section VI below, there is a strong correlation between the TCM values by river developed in Duffield, Loomis and Brooks (1987) and the logit mean estimates presented here.

Sensitivity of the mean estimates to higher truncation levels varies somewhat by river. For example, the mean for the Boulder at $250 truncation is $97 while the value is $149 at a $500 maximum bid. By contrast, the mean for the Missouri varies from only $59 to $63 for truncation at $300 and $500. With reference to Table 12, this difference in sensitivity is due to the relative magnitude of the coefficient on the bid variable for the two rivers (-.64 versus -1.62). In other words, the probability of a "yes" response drops off very rapidly with higher bid values for the Missouri.

In general, the sensitivity of mean values per trip to the upper limit of integration is a major weakness of the logit method. For this application, the problem appears to be compounded by two limitations of the survey sample. The first limitation is that it appears that bids higher than $500 should have been used on at least some of the rivers in order to establish the point at which the probability of a yes closely approaches zero. For example, on the Big Hole river 100 percent of respondents that were asked if they would pay $500 indicated they would pay that amount to fish at current conditions. However, the 100 percent response is unfortunately based on a sample of one. Accurate information on the upper end of the bid distribution was further limited by the failure to allocate a representative share of bid questions to high bid levels. Specifically there were 27 bid categories varying from $1 to $500 or an average of 81 bid questions for every dollar bid level (given a total of 2183 completed surveys). However, only an average of about 25 bid questions were for the top three bid values ($300, $400 and $500). In other words, on average each of the 17 rivers would have at best one to two bid questions at $500.

The basic result of these sample limitations is that on seven of the rivers no respondents were faced with a $500 bid. Not surprisingly, this group of seven rivers includes all three rivers with the smallest samples in the study (Smith at 44, Flathead at 65 and Boulder at 69). This is particularly a problem on rivers that are likely to have relatively high values. For example, on the Upper Yellowstone, the highest bid level asked was $300 and two out of three indicated a willingness to pay this amount. On the other hand, the sample size and number of high value bid questions may have been sufficient for other rivers. For example, on the Missouri the highest bid asked was $300 (zero yes for the one $300 bid asked or 0/1) but responses approach zero for even lower bids: 1/8 at $200 and 2/9 at $100. As will be recalled, the Missouri mean value is not particularly sensitive to truncation. This is in part because the Missouri sample is relatively large (148 responses) and because the upper limit is probably well established.

Perhaps the river where the upper limit is most poorly established is the Big Hole. At $500, the yes response proportion was one of one and at $400 the response was two of three. It is not clear at what bid levels the probability of a yes would approach zero for this river. To provide further perspective on the logit distributions, values were calculated for each river using as an upper limit the point where the probability of a yes response dropped to 10 percent. This limit on the Missouri corresponds to a bid of $137 but on the Big Hole is $11,409. The corresponding mean values are $50 on the Missouri but $2142 on the Big Hole. In addition to the Big Hole, two other rivers show a 10 percent probability of a yes at very high bid levels: the Beaverhead (at $2669) and the Gallatin ($6342). The corresponding mean values at $586 and $1166 at a 10 percent upper limit of integration. The Gallatin, like the Big Hole showed a yes response to the one $500 bid asked.

Median bids are also displayed in Table 26. These tend to be no more than one-half to as little as one-sixth the value of the corresponding mean.

The range across rivers in the bid response for doubled chances of catching large trout and doubled trout catch (Tables 27 and 28 respectively) are similar to the range in the current conditions bids.

The means for a given river can also be compared across bid questions as summarized in Table 29. Nine rivers show the bid for large trout and doubled catch both being larger than the current conditions bid. If the latter holds, anglers are willing to pay for an improvement in current conditions on the given river. Based on comparison of means, three rivers show anglers willing to pay considerably more for large trout but not doubled catch: the Beaverhead, Big Hole and Madison. On two rivers (Gallatin and Rock Creek), current conditions mean values were larger than either of the other bid values. (For a listing of rivers in each category see Table 42 below and the accompanying discussion.) Further analysis would be needed to determine if these relative responses are a function of angler perception of management problems or potential on a river (quality of the fishery) or if responses mainly indicate what types of angler groups predominate on a given river. It may be that relative responses are a function of both types of factors.

A limitation of the analysis is that confidence intervals are not readily available for the logit means. It is therefore not possible to say if the differences across bids by river are statistically significant. The only statistical output available with regard to confidence intervals from the SPSSx probit package is an interval on the median for a simple bivariate (logit as a function of bid level only) model. These bivariate equations and estimates are not reported here; however, a comparison of medians from a bivariate model across bid questions is summarized in Table 30. The comparison is between the median bid by river for current conditions versus either doubled chance of catching large trout or doubled trout catch. For an informal test, medians were classed as significantly different if the median of one bid question lies outside the confidence interval on the median of another bid. The basic finding is that on approximately 60 percent of the rivers, anglers were willing to pay significantly more for doubled chances of catching large trout. By contrast, anglers were willing to pay significantly more for doubled catch on only around 15 percent of the rivers.

F. Open CVM by River

Tables 31 through 39 provide a summary of the open CVM mean (and median) bids by river. The three bid questions are summarized for three different samples: complete (excluding only protest bids), subsample excluding zero bids and subsample excluding zero bids and bids greater than $500.

The mean bids are summarized for all three bid questions for the complete sample in Table 31. For current conditions, the mean bids range from $5 for the Upper Clark Fork to $52 for the Madison. With respect to confidence intervals, the underlying population distribution of bids are not normal (recall Table 20). However, the sample sizes are sufficiently large (greater than 50 except the Upper Clark Fork and South Fork of the Flathead) that the central limit theorem applies. Assuming then that the distribution of the sample means is normal, the ninety percent confidence intervals are plus or minus the standard error estimate times 2.0. For example, the 90 percent interval for the mean bid value on the Madison is about $32 to $72. Because of extreme values, confidence intervals on some rivers are quite large. On the Upper Yellowstone, the mean is $60, but the confidence interval is approximately $10 to $110. As can be noted, when extreme values are excluded (Table 37 for example), the standard errors tend to decline. For example when zero bids and bids over $500 are excluded, the Upper Yellowstone mean declines to $46 for current conditions (Table 37), but the confidence interval is approximately $24 to $68 (a somewhat more precise estimate). The implication is that a possible basis for selecting an appropriate open CVM subsample is improved statistical properties of the estimate.

Mean bids across bid questions are compared in Table 40 for the subsample where zero bids are excluded. Only about one third of the sample shows either increased catch of large trout valued greater than current conditions or doubled catch valued more. The other two-thirds of the rivers of course show the opposite direction. Since standard errors are available, statistically significant differences can be identified. For the subsample where both kinds of extreme values are excluded (zeros and greater than $500), only on the Upper Clark Fork are anglers willing to pay significantly more for either larger trout or more trout.

The differences across bid questions for the open CVM and logit estimates by river are summarized in Table 41. The comparison excludes the Upper Clark Fork and the South Fork of the Flathead as samples were too small for the logit estimate to converge. The logit shows twice as many rivers where there is willingness to pay for improved conditions (12 versus 6 to 7 for open CVM). The specific rivers that fall in each relative bid category are shown in Table 42 for each methodology. For example, rivers where anglers were willing to pay only for larger trout improvement included the Beaverhead, Big Hole and Madison using the logit method but the Gallatin and Smith by the open CVM. In general, the two methods suggest completely different patterns. The only agreement for the two methods is on the Clark Fork (only doubled trout catch has positive value) and on the Flathead and Kootenai (both improvements have positive value). Given the limitations of the open CVM response as discussed above and in the absence of further information, the logit is probably the more reliable.

VI. COMPARISON OF CVM AND TCM ESTIMATES BY RIVER

This section provides a comparison of site specific net economic values per trip for Montana trout fishing. Three basic methods of estimating values for nonmarket use are compared: TCM (from Duffield, Brooks and Loomis, 1987), dichotomous choice CVM and open-ended CVM (from the current study). The TCM estimates are based on a 1985 survey while the CVM are for 1986. No attempt has been made here to correct for changes in overall price levels or for general fishing conditions (1985 was a drought year). These differences are likely to be minor compared to differences across methods. Values are compared for the 17 different river sections where estimates were available for all three approaches.

For each of the basic methods, several alternative measures have been developed as follows: logit mean, logit median, open CVM mean and median (both with and without zero bids included), TCM based on either standard or reported cost, and TCM based on predicted versus actual trips. (The latter is the Gum and Martin method.) The basis for these ten specific estimates has been developed in detail above and in Duffield, Brooks and Loomis (1987).

Based on the detailed development elsewhere, there is some a priori expectation of what comprises the "best" estimates. In general, means are preferred to medians as a measure of central tendency. Only means can be correctly used to infer aggregate site values from value per trip estimates. (In addition, TCM estimates are only available for means.) With respect to the open CVM, the large number of zero responses and the inconsistency with the logit responses suggests that the open CVM was not particularly successful in this application. As was noted in the literature review, other analysts have had reservations about the ability of open CVM questions to elicit participation and meaningful responses. Within the open CVM the most credence can perhaps be attached to estimates where zero bids are excluded. Based on previous studies comparing CVM estimates to cash transaction responses (as described in the literature review), the logit estimated means should be fairly reliable. Within the TCM estimates, one might expect that travel costs based on actual reported costs would be superior to use of a price specification based on so-called "standard" costs of owning and operating a vehicle. In addition, as developed in Duffield, Loomis and Brooks (1987) the TCM estimates based on using actual trips (Gum and Martin method) avoid the bias due to model prediction error.

Table 43 provides a listing of mean and standard deviation across all 17 sites for the ten estimates. It should be recalled that three different bid questions were asked in the CVM survey. The TCM estimates are comparable to the current conditions CVM bid questions. For completeness, Table 43 also provides a listing of variables for the large trout and doubled catch bid questions as well. The focus here will be on examining consistency between the various measures of value for trips taken on a given river under current conditions.

One basic result from Table 43 is that median estimates tend to be below the means. This suggests that the distribution of net values per trip is not symmetrical about the mean but is skewed toward the higher end of the value scale. Logit means are about two and one-half times as great as the average median value ($127 versus $49); open CVM means and medians are in about the same ratio ($50 to $17).

The TCM estimates are based on average (or mean) net economic value. Accordingly, the correct comparison is to the estimated means for the logit and open CVM estimates. The logit mean (based on an upper limit of integration of $500 at all sites) is $127. The TCM estimate based on the Gum and Martin method and reported costs (hereafter TCMGR) is quite similar at $122. (Corresponding standard deviations are also quite similar between these two estimates at $58 and $60 respectively). The TCM estimate based on predicted trips and reported costs is somewhat higher (TCMPR at $179). Both TCM estimates based on standard costs are about one-half as great as the corresponding reported cost estimate (reflecting the difference in the standard and reported travel cost per mile parameter of 12.6 and 27.0 cents respectively). The open CVM average for site means is $28 for the complete sample and $51 when zero bids are excluded.

A complete listing by river of the ten current conditions estimates is provided in Table 44.

Another way to describe the similarity or differences across estimates is to examine the site level correlation. Table 45 provides a listing of Pearson and Spearman correlation coefficients. The Pearson product moment correlation coefficient shows the correlation taking into account actual dollar differences between the estimates. The Spearman correlation is based on nonparametric methods and shows the similarity in site ranking between the methods. The two statistics provide very similar results here. One basic finding is that the correlation between the Gum and Martin TCM estimates and the logit mean is quite strong (.71 to .73) and nearly double the correlation of the logit and predicted TCM (.38). This is in accord with a priori expectations. The logit mean and the open CVM means are also positively correlated at .43 to .49 for the various measures. While the open CVM means are also correlated to the Gum and Martin TCM estimates (.47 to .61), there is no significant correlation between the open CVM means and the predicted TCM estimates (correlation is .04 to .14).

The basic conclusion, based on site averages and correlation analysis, is that the logit mean and the TCM estimates derived from reported costs and the Gum and Martin approach (TCMGR) are the most consistent of the various estimates. This is in accord with expectations based on a review of the methods. In the following section, the logit mean and TCMGR are examined in greater detail to explore remaining differences.

Table 46 provides a listing of logit and TCMGR estimates by river, including a description of sample size. This listing also provides the ratio of TCM/CVM estimates by site. As can be determined from the ratio statistic, most estimates (in fact, 11 of 17) are within a 25 to 35 percent range of the corresponding site estimate. This similarity is perhaps the most that one could hope for, given the statistical models involved and the sample sizes. Unfortunately, there is not currently available in the literature a method of calculating confidence intervals for the TCM estimates. It is likely that were the appropriate statistics available, the precision of the TCM estimates would prove to be no better than the precision of open CVM site level estimates for comparable sample sizes. (As can be readily determined from Table 33, the 90 percent confidence interval on the mean for most of the sites in this study is no better than plus or minus 50 percent of the estimate.) The point here is that it is likely that at least for 11 of the sites (and perhaps for all), the TCM and logit CVM estimates are not significantly different. It would appear that the site level results here provide strong validation for both models. The similarity of estimates is remarkable given the very different methods and separate data bases employed.

Examining the site level estimates in greater detail, it can be noted that estimates for four of the rivers (the Madison, Gallatin, Missouri and Stillwater) are in fact within 10 or 11 percent of the corresponding estimate. For example, the TCM estimate for the Madison is $234 while the logit CVM is $228. The similarity of the estimates is encouraging in that all four rivers have relatively large sample sizes for both CVM and TCM. Specifically, the Madison, Gallatin and Missouri have the three largest TCM samples (265 to 396 trips) and are among the four largest CVM samples (148 to 155 observations). Correspondingly, the poorest agreement across sites if for rivers with relatively few observations. Specifically, the TCM and CVM estimates for Rock Creek, Boulder, Flathead, Beaverhead, Smith, Upper Yellowstone and Kootenai diverge by a ratio of nearly 2:1 to 1.5:1. These seven rivers include all four of the thinnest TCM samples (less than 5 trips per zone) and all five of the smallest

CVM samples (less than 80 observations). Only the Beaverhead is something of an anomaly in that both the CVM sample (108) and TCM sample (120 trips or 6.3 trips/zone) are at least average. The differences on the Beaverhead may be related to imprecise estimates of response proportions at high bid levels as noted above.

The influence of sample size as noted here is encouraging with regard to validation of both the TCM and CVM models. It appears that precision of the estimates is related to sample size, as one would expect. Much of the difference between the two methods in this application appears to be largely attributable to limited samples.

Table 47 provides a comparison of correlation coefficients between CVM and TCM for the complete sample of 17 rivers and also for the subsample of 12 rivers with at least 80 CVM observations. The correlation coefficients (both Pearson and Spearman) improve for the TCMGR and logit mean correlation when small sample size sites are excluded. For the complete sample the correlation is .71 (Spearman) to .73 (Pearson); for the subsample of 12 rivers the correlation is .80 to .81, which is a very high correlation. Interestingly, the correlation between logit mean and predicted TCM values is worse for the smaller sample (drops from .51 to .38). This provides further evidence that the Gum and Martin approach is probably more accurate than use of predicted trips in calculating net values from the stream TCM model. The correlations are also worse for logit mean and the open CVM mean and TCMGR-open CVM when sites with less than 80 logit CVM observations are excluded. In fact, the latter correlations are no longer significant at the 10 percent level based on the Spearman correlation. In general the evidence suggests that the logit mean and TCM estimates based on the Gum and Martin method are the most consistent.

Another perspective on comparison of the alternative estimates is provided by bivariate linear regression analysis summarized in Table 48. Logit means and open CVM means are regressed on all four TCM estimates (Gum and Martin and predicted for both standard and reported costs). If the values compared were nearly identical, the intercept term would approach zero and the slope coefficient would approach plus 1.0. For the full sample set, the overall equation between logit means and predicted TCM values is not significant at the 10 percent level. The adjusted R square statistic is very low (.09) indicated a poor correlation. The regression model however shows a good fit between logit means and TCM Gum and Martin values. The adjusted R square is .49 and the overall equation is highly significant based on the F statistic. The intercept is $42, but based on a t-test the intercept is not significantly different from zero at the 90 percent level. The slope coefficient for the standard cost model is 1.483 and the reported cost model is .692. Both are highly significant, and the 90 percent confidence interval includes the value 1.00. The basic conclusion is that the bivariate regression indicates a good correlation between the logit mean and TCM Gum and Martin estimates.

The bivariate regression model relating open CVM (zero bids excluded) and the TCM estimates is also reported in Table 48. The basic finding is that there is almost no correlation between the open CVM means and the predicted TCM, but there is a significant correlation to the Gum and Martin TCM (adjusted R square of .335), though not as strong as the logit mean correlation.

When the subsample excludes CVM sites with fewer than 12 observations, the TCM predicted model is barely significantly correlated to the logit mean. The logit mean and TCM Gum and Martin estimate model also improves and shows high explanatory power (adjusted R square of .603). The intercept moves closer to zero ($36) and the slope coefficients are 1.682 and .785. The latter model shows a slightly better relationship for the reported than for the predicted TCM.

VII. SUGGESTIONS FOR FUTURE RESEARCH

This section provides a brief summary of suggestions relating to future research.

Perhaps the major limitation of this study was the sample size and the distribution of bids asked on the logit portion of the survey questionnaire. Future research of this type would be improved if a minimum of 150 to 200 observations per site could be obtained. In addition, it was found that the highest bid asked in this study ($500) was insufficient to identify the point at which the probability of a "yes" response approaches zero for a number of rivers. It would be useful in future research to more carefully pretest the bid range. In addition, it is essential that a fair proportion of the survey questionnaires utilize bids from the higher range.

A major analytical issue that should be explored is the implication of alternative measures of central tendency for the estimated net economic values. Within the conventional logit framework, both the mean and median are plausible candidates. In addition, Cameron (1987) has proposed an alternative methodological framework that could be applied in future work.

An interesting finding in the current study is that net willingness to pay for improvements in fishing quality (either larger trout or more trout) vary considerably across rivers both in magnitude and pattern. For example, on some rivers only improvements in chances of catching large trout had positive values. The existing data base could be utilized in an economic analysis of management alternatives relating to catch. Such a project would require at least a simple model of how management alternatives and fishing pressure affect the fishery population and success rates. Given the economic valuation, the management alternative that maximizes net present worth could be identified.

The existing data base could also be used to explain the observed differences in net willingness to pay for fishery quality improvements across river sites. For example, is net willingness to pay for improved fishery quality largely a function of the site's current characteristics or a function of who is fishing the given site. The answer is probably a mixture of both phenomenon. It may be possible for example to exploit the cluster analysis characterization of fishermen types in pursuing this line of research. What is needed is a model that better relates site (including management) characteristics to how many and what type of fisherman is attracted.

A related line of research that would appear to be the logical next step in the analysis of Montana fisheries is to more formally integrate the economic analysis into a biological and physical model of a given fishery. For example, the biological structure (age distribution and size class) of the fishery influences the type of fishing opportunities available (success rates, proportion of trophy fish, etc.). This in turn influences the economic demand for the site (number and type of visits). Over time this social and biological system interaction is modified and directed by management. For example, catch and release regulations modify the impact of fisherman on the age and size structure of the biological population and therefore impact future opportunities (success, etc.) and economic demand. This area of research requires that time be explicitly incorporated in the model and that the simultaneity between the biological and social systems be recognized. A model for this area of research is the work that has been done in applying mathematical bioeconomics to marine fisheries. To date, this level of sophistication has not been achieved in the analysis of fresh water fisheries. The nature of this research might imply initially modeling a single site (as opposed to the multi-site direction of the current research). Latter the methodology could be extended to multiple sites to better account for site substitution.

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APPENDIX A

SURVEY QUESTIONNAIRE

Thank you for your help. Is there anything else you'd like to tell us about hunting in this area? We would appreciate any comments.

Thanks again. If you would like to receive a copy of the survey results, please write "Results requested" and your address on the back of the return envelope (not on this questionnaire).

MONTANA
ELK HUNTING SURVEY
1986

Montana Department of
Fish, Wildlife & Parks

I. FIRST, WE HAVE SOME GENERAL QUESTIONS ABOUT YOUR HUNTING.

1. How many years have you been hunting elk? _____ Years

2. About how many days per year do you hunt elk? _____ Days

3. How many of these days are spent in Montana? _____ Days

4. How would you rate elk hunting compared to your other outdoor recreation activities? (please check one)

___ It's my favorite outdoor recreation activity

___ It's one of my favorite outdoor recreation activities

___ It's just one of several outdoor recreation activities that I do

___ I prefer other outdoor recreation activities

II. THE NEXT QUESTIONS ASK ABOUT YOUR MOST RECENT ELK HUNTING TRIP IN MONTANA DURING THE GENERAL SEASON.

1. Approximate dates(s) of this last trip: ____________

(A trip could be anything from an hour to several or more days)

2. Use the map provided to show what HUNTING AREA you visited on this trip. (If you hunted in more than one area, write the number of the ONE area where you spent the most time)

Number of hunting area (from map on back of the cover letter): ____________

IN ALL OF THE FOLLOWING QUESTIONS, "THIS AREA" MEANS THE AREA WHOSE NUMBER YOU JUST LISTED.

3. On this trip, how many days did you hunt in this area?

___ Days

4. About how many hours per day did you hunt? ___ Hours

5. About how many elk did you see while hunting in this area?

___ Elk seen in this area

6. Did you kill an elk in this area? ___ Yes ___ No

7. If yes, what kind did you get?

___ Antlered ___ Antlerless

If your elk was antlered, how many points did it have on each side?

Points on side 1: _____ Points on side 2: _____

7a. District number where elk was killed (from map): ___

8. Did you get any other big game in this hunting area?

___ Yes ___ No

9. If yes, what species did you shoot?

___ Mule deer ___ Bear

___ White-tailed deer ___ Other: ____________

10. Was this area the only place you hunted on this trip, or did you hunt in other areas listed on the map? (Please check one)

___ This area was the main or only one I hunted on this trip away from home

___ This area was one of several areas I hunted in on this trip

11. If you did hunt in other areas on this trip, please list the area numbers from the map:

____

12. What type of equipment did you use in this area? (please check all that apply)

___ Muzzle loader ___ Rifle ___ Bow and arrow

13. Did you hire a hunting guide or outfitter in this area?

___ Yes ___ No

14. Was hunting the main purpose of your trip away from home when you hunted in this area or did you make the trip for other reasons such as business or a family vacation? (please check one)

___ Hunting was the main purpose of this trip

___ Hunting was one of several reasons for making the trip

15. Which of the following items did you use while hunting in this area? (please check all items you used)

___ Dirt bike or ATV

___ Horse

___ Binoculars

___ Topographic map

___ Backpacking tent

___ Trailer

___ Wall tent

___ Snowmobile

___ Elk bugle

___ Camera

___ Spotting scope

___ Motor home

16. About how far did you walk while you were hunting in this area? (please use an average if you hunted more than a day)

___ miles

17. About how many other hunters (not in your party) did you see while you were hunting this area on this trip?

___ Other hunters

18. Was this number of hunters: (please check one)

___ More than I expected to see

___ About as many as I expected to see

___ Fewer than I expected to see

___ I didn't have any expectations

19. Did the other hunters present affect your enjoyment of the hunting in this area?

___ Yes ___ No

20. If yes, please explain how:

21. Was this the first time you hunted in this particular area?

___ Yea ___ No, I've hunted here before

22. If No, how many years have you been hunting in this area?

_______ Years

23. How does this area rate compared to other areas in Montana? (please check one)

___ It's my favorite place to hunt

___ It's one of my favorite places to hunt

___ It's one of many places where I hunt

___ I prefer to hunt other placea

24. For hunting purposes, do you feel the number of roads to vehicle use in thia area is: (please check one)

___ Too few

___ About right

___ Too many

25. In the last few years, has the number of open roads in this area increased, decreased, or stayed the same? (check one)

___ Number of open roads in this area has increased

___ Number of open roads in this area has decreased

___ Number of open roads in this area is the same

___ I'm not sure

26. For game retrieval purposes, how do you feel the existing roads in this area should be managed? (please check one)

___ Hunters should be allowed to use only open roads to retrieve game with a vehicle

___ Hunters should be allowed to use closed roads to retrieve game with a vehicle

___ Hunters should be allowed to use vehicles off roads to retrieve game

27. How many separate trips did you make from your home to this hunting area this season?

___ Separate trips from home this year

28. About how frequently do you plan to hunt in this area in the future? (please check one)

___ As frequently as I do now

___ More frequently than I do now

___ Less frequently than I do now

29. Are there any other hunting areas in Montana that you feel provide a hunting experience comparable to the this particular area?

___ Yes ___ No

30. If yes, please list the numbers of any other comparable hunting areas from the map:

____

31. Suppose you were told you could not hunt elk in this area on this trip. What other area might you have hunted instead?

Please specify area number from map: __________

32. About how far is it from your home to this alternative hunting location?

___ Miles

33. How does it compare to hunting where you did?

34. People hunt for many reasons. We'd like to know some of the reasons you hunted this area on this trip, to help us understand different types of hunters and their preferences.

Following is a list of possible reasons for hunting. Please check the box that says whether that reason was very important, important, not important, or not at all important a reason you hunted in this particular area on this trip.

	Very Important	Important	Not very Important	Not at all Important	Not Sure
1. Good road access	☐	☐	☐	☐	☐
2. For the solitude	☐	☐	☐	☐	☐
3. Because there are lots of elk there	☐	☐	☐	☐	☐
4. To test my hunting skills	☐	☐	☐	☐	☐
5. It's close to home	☐	☐	☐	☐	☐
6. To get a trophy elk	☐	☐	☐	☐	☐
7. To be outdoors	☐	☐	☐	☐	☐
8. I've had good hunting here	☐	☐	☐	☐	☐
9. For the meat	☐	☐	☐	☐	☐
10. To view the scenery	☐	☐	☐	☐	☐
11. Because I had a special permit for the area	☐	☐	☐	☐	☐
12. To be in a natural setting	☐	☐	☐	☐	☐
13. To hunt with family members	☐	☐	☐	☐	☐
14. It's where my friends were going	☐	☐	☐	☐	☐
15. To get away from other hunters	☐	☐	☐	☐	☐
16. To be in rugged country	☐	☐	☐	☐	☐

17. Could you please look back over this list and circle the numbers of the three most important reasons you hunted in this area on this trip?

III. THE NEXT FEW QUESTIONS WILL HELP US TO UNDERSTAND THE VALUE YOU PLACE ON HUNTING IN THIS AREA.

WE REALIZE YOU AREN'T USED TO CONSIDERING HUNTING THIS WAY, BUT PLEASE THINK ABOUT IT AND GIVE US YOUR BEST ESTIMATE!

1. About how far is it from your home to where you hunted in this area on this trip?

______ Miles (one-way)

2. How long did it take to travel from your home to this area?

___ Hours (include any stops made en route)

3. If you drove, how many other hunters were in the vehicle?

___ Number of other hunters

4. About how much did you personally spend on this trip? If you can't recall the exact amount, please give your best estimate for each of the following three types of expenses.

_______ Amount I spent for transportation (gas, car rental, airfare and any other transportation costs)

_______ Amount I spent on food, beverages, and lodging

_______ Amount I spent on equipment purchased just for this trip, access or guide fees, and all other expenses

_______ TOTAL AMOUNT I SPENT ON THIS HUNTING TRIP

5. Was this trip worth more than you actually spent?

___ Yes ___ No

6. If YES, would you still have made the trip if your share of the expenses had been $400 more?

___ Yes ___ No

7. What is the maximum increase in your actual trip cost you would have paid to hunt this specific area instead of hunting elsewhere?

_________ Dollars

8. If your answer was zero, could you briefly explain why?

9. Imagine that everything about this last trip were the same, except that your chance of getting a 6-point or better bull elk was twice as great AND that your trip costs were $350 more than your actual costs. Would you still have made the trip under these circumstances? (please check one)

___ Yes, I would still have made the trip

___ No, I would not have made the trip

10. What is the maximum increase in actual trip costs you would pay to double your chances of getting a 6-point or better bull elk?

________ Dollars increase in trip cost

11. If your answer was zero, could you briefly explain why?

12. Imagine that everything about this last trip were the same, except that you saw half as many hunters as you actually did AND your trip costs were $450 more than they actually were. Would you still have made the trip under these circumstances? (please check one)

___ Yes, I would still have made the trip

___ No, I would not have made the trip

13. What is the maximum increase in actual trip costs you would pay to reduce by half the number of hunters you saw while hunting in this area?

________ Dollars increase in trip cost

14. If your answer was zero, could you briefly explain why?

IV. THE NEXT FEW QUESTIONS ASK YOUR OPINION ON DIFFERENT STATEWIDE HUNTING MANAGEMENT OPTIONS.

1. Managing for a diversity of opportunities to hunt elk may require more hunting regulations. However, these regulations would restrict your hunting opportunities. We'd like to know your opinions on the following types of potential regulations to maintain a diversity of hunting opportunities in Montana.

For each regulation, circle the answer showing whether you favor that regulation, do not favor it but would accept it if necessary, do not find the regulation acceptable, or would need more information to decide.

A. No special permit to hunt bull elk would be needed. There would be considerable competition for bull elk but no restrictions other than having a license. You could hunt every year but your odds of getting a bull would be less than 1 in 10. Please circle one:

Favor — Do not favor but would accept it — Would not accept it — Would need more information

B. An unlimited number of bull elk permits would be available. You would be able to get a permit every year but you would have to choose the one district where you would hunt and not be able to hunt in any other districts. Please circle one:

Favor — Do not favor but would accept it — Would not accept it — Would need more information

C. A limited number of bull elk permits would be available through a drawing in June. You would have to choose the one district where you would hunt and not be able to hunt in any other districts. You might get a permit only once every 5 years, but if you did obtain a permit you would have a much better chance (than 1 in 10) of getting a bull. Please circle one:

Favor — Do not favor but would accept it — Would not accept it — Would need more information

D. The taking of bull elk would be subject to point regulations. Hunters could shoot only bulls that had at least one antler with 2 or more points. Please circle one:

Favor — Do not favor but would accept it — Would not accept it — Would need more information

E. The taking of bull elk would be subject to point regulations. Hunters could shoot only bulls that had at least one antler with 5 or more points. Please circle one:

Favor — Do not favor but would accept it — Would not accept it — Would need more information

F. To reduce pressure on bulls, antlerless elk permit holders would be allowed to hunt only antlerless elk and only in the hunting district where their permit was valid. Please circle one:

Favor — Do not favor but would accept it — Would not accept it — Would need more information

V. THESE LAST FEW QUESTIONS WILL HELP US UNDERSTAND YOUR RESPONSES BY KNOWING SOME BASIC INFORMATION ABOUT YOU.

1. Where are you from? City: ____________________ State: ________

2. What is your age? ________ Years

3. Are you: ___ Male ___ Female

4. Are you a member of any hunting, conservation, or sport organizations?

___ Yes ___ No

5. If so, which ones?

6. What is the highest year of formal education you completed?

___ Some grade school
___ Finished grade school
___ Finished junior high school
___ Finished high school
___ Some college
___ Finished college
___ Some postgraduate work
___ Finished postgraduate

7. If you had not gone hunting this trip, would you have been working instead?

___ Yes ___ No

8. During the hunting season this year, were you: (check one)

___ Employed full time
___ Employed part time
___ Unemployed
___ Retired
___ Homemaker
___ Other: ______________

9. Please check your household's income before taxes last year:

___ Under 5,000
___ 5,000 - 9,999
___ 10,000 - 14,999
___ 15,000 - 19,999
___ 20,000 - 24,999
___ 25,000 - 29,999
___ 30,000 - 34,999
___ 35,000 - 39,999
___ 40,000 - 49,000
___ 50,000 - 74,999
___ 75,000 - 100,000
___ over 100,000

TABLES

Table 1

Response Rate on Angler Preference Survey

River	Questionnaires Mailed	Returns
Beaverhead	151	125
Kootenai	107	79
Bighorn	197	172
Clarkfork	182	146
Upper Clarkfork	38	35
Stillwater	176	136
Rockcreek	124	101
Upper Yellowstone	179	140
Middle Yellowstone	145	115
Boulder	93	77
Flathead	107	84
Southfork Flathead	15	14
Smith	62	50
Missouri	201	165
Blackfoot	134	107
Big Hole	185	158
Gallatin	200	162
Bitterroot	160	131
Madison	216	174
TOTAL	2,672	2,171

Overall response rate: 81.3 percent

Table 2

Multivariate LOGIT Equations Complete Sample

n	Constant	DOLAMT	DOLDBLE1	DOLDBLE2	COMPARE	TCOMPARE	STRPSHM	LRGCOT	RVRMAIN	REASON	HRSDAY	DYSFSHED	TROUTCOT	REASON06	INCCME
A) Current Conditions:															
1749	1.52706	-.8315			-.5346	-.72730	-.30326	.21946	.92470	.29078	.41556	.43066			.49974
	(27.14)	(-16.65)			(-3.53)	(-4.89)	(-5.61)	(5.55)	(4.62)	(4.12)	(3.33)	(4.45)			(5.79)
B) Large Trout:															
1751	4.22908		-1.23028		-.52836	-.70772	-.26544	.15792	1.04056	.44008		.76724	.0868	-.3871	.4745
	(31.05)		(-19.22)		(-3.14)	(-4.30)	(-4.47)	(3.32)	(4.74)	(2.46)		(6.65)	(1.92)	(-2.72)	(5.05)
C) Double Catch:															
1751	2.69894			-.99800	-.63242		-.28044		.54676	.36476		.62172	.10466		.39514
	(33.38)			(-18.12)	(-4.09)		(-5.17)		(2.78)	(2.20)		(6.14)	(2.59)		(4.43)

Notes:
DOLAMT = Bid amount for current condition question.
DOLDBLE1 = Bid amount for large trout question.
DOLDBLE2 = Bid amount for doubled catch question.
COMPARE = Rate fishing compared to other activities: favorite (1) to prefer other activities (4).
TCOMPARE = Rate river compared to others: 1 = favorite to 4 = prefer others.
STRPSHM = Separate trips from home to this river per year.
LRGCOT = Number of large trout caught this trip.
RVRMAIN = River was main trip destination (1) to other rivers more important this trip (3).
REASON = Fishing was main reason for trip (1) to not main reason reason (3).
HRSDAY = Hours per day fished this trip.
DYSFSHED = Days fished this trip.
TROUTCOT = Trout caught this trip.
TROUTKPT = Trout kept this trip.
REASON06 = Reason to fish is to catch large trout: very important (1) to not at all important (4).
INCOME = Mean household income category (under 5000 to over 100,000).
DYSFSHYR = Total days fished per year.
YRSFSHRV = Years fished this river.
AGE = Age in years.

Table 3

Open CVM Equations for the Full Sample

Dependent	Constant	DYSFSHED	STRPSHM	HRSDAY	DYSFSHYR	YRSFSHRV	TROUTCOT	TROUTKPT	LRGCOT	RVRMAIN	REASON	REASON06	COMPARE	ICOMPARE	INCOME	AGE
Current Conditions:																
DOLTOGO	3.23386	+.438929	-.221208	+.262049	---	---	+.093448	-.039817	+.070983	+.491481	+.289235	---	-.257511	-.424015	+.261283	-.319673
	(7.30)	(7.09)	(-6.60)	(2.98)			(3.41)	(-1.75)	(2.67)	(3.73)	(2.53)		(-2.63)	(-4.52)	(4.77)	(-3.19)
Observations: 882		$\bar{R}^2$: .327		F: 36.732												
Large Trout:																
DBLECOT	1.528319	+.375509	-.226532	+.226016	+.180273	-.105437	+.103995	-.059049	+.049631	+.412325	+.280519	-.174817	---	-.216767	+.302947	---
	(5.84)	(6.63)	(-6.49)	(2.83)	(3.87)	(-2.96)	(4.16)	(-2.82)	(2.02)	(3.43)	(2.77)	(-2.32)		(-2.57)	(6.28)	
Observations: 965		$\bar{R}^2$: .332		F: 37.802												
Double Catch:																
DOLDBLCOT	2.184783	+.446008	-.262674	+.168714	+.207911	---	+.087427	-.065411	+.0643	+.40229	+.262049	-.155942	---	-.277059	+.347062	-.266908
	(5.75)	(7.47)	(-7.45)	(2.17)	(4.48)		(3.44)	(-3.18)	(2.62)	(3.38)	(2.61)	(-2.05)		(-3.27)	(7.02)	(-2.97)
Observations: 925		$\bar{R}^2$: .368		F: 42.377												

Note: DOLTOGO = bid response variable for current conditions.
DBLECOT = bid response variable for doubled catch of large trout.
DOLDBLCOT = bid response variable for doubled catch.

For other variable definitions, see Table 2.

Table 4

Open CVM Equations for the Full Sample Including Starting Bids

Dependent	Constant	DOLAMT	DOLDBLE1	DOLDBLE2	DYSFSHED	STRPSHM	HRSDAY	DYSFSHYR	YRSFSHRV	TROUTCOT	TROUTKPT	LRGCOT	RVRMAIN	REASON	REASON06	COMPARE	TCOMPARE	INCOME	AGE
Current Conditions:																			
DOLTOGO	2.703535	+.106477	---	---	+.407767	-.24308	+.230909	+.089897	---	+.073974	---	+.064101	+.450130	+.256467	---	-.205154	-.42024	+.276893	-.333833
	(5.79)	(4.27)			(6.58)	(-6.51)	(2.61)	(1.71)		(2.79)		(2.45)	(3.44)	(2.26)		(-2.06)	(-4.45)	(5.12)	(3.39)
Observations: 882		$\bar{R}^2$: .340		F: 35.926															
Large Trout:																			
DBLECOT	1.22353	---	.127944	---	+.407921	-.192976	+.205327	+.16278	+.097272	+.100607	-.063505	+.052364	+.42774	+.234285	-.176842	---	-.193037	+.270571	---
	(4.65)		(5.79)		(7.29)	(-5.62)	(2.63)	(3.57)	(-2.80)	(4.12)	(-3.10)	(2.18)	(3.65)	(2.36)	(-2.40)		(-2.34)	(5.72)	
Observations: 962		$\bar{R}^2$: .363		F: 40.045															
Double Catch:																			
DOLDBLCT	1.890514	---	---	+.100265	+.435415	-.246613	+.150203	+.201052	---	+.085963	-.060276	+.05881	+.39546	+.252679	-.158581	---	-.264315	+.339326	-.264984
	(4.94)			(4.32)	(7.35)	(-7.01)	(1.94)	(4.36)		(3.40)	(-2.93)	(2.42)	(3.35)	(2.53)	(-2.10)		(-3.14)	(6.90)	(-2.96)
Observations: 921		R^2: .381		F: 41.425															

Table 5

Summary of Cluster Type Characteristics

	Generalist	Generalist	Occasional	Specialist
% Flies	30	34	29	60
% None Caught	15	14	34	15
% High Catch Rate	24	21	16	19
% Large Caught	51	50	73	54
% Fish More Than 50 Days per Year	18	20	7	20
% Fishing is Favorite Activity	20	22	14	30
% on Favorite Stream	22	23	14	15
% Main Reason Trip	74	77	68	69
% Main River Fished	89	88	92	77
% Yes Management Problems	49	44	40	43
% Fishing the Madison	6	8	5	13
% Fishing the Bitterroot	5	5	7	6
% Montana Resident	81	72	83	58
% 10 to 20 Years Old	6	10	6	7
% of Group with Income Greater Than $100,000	9	13	11	68

Table 6

Multivariate Logit Equations

For Current Conditions by Cluster

Cluster	Constant	DOLAMT	STRPSHM	INCOME	DYSFSHED	LRGCOT	HRSDAY	COMPARE	TCOMPARE	REASON	RVRMAIN	DYSFSHYR
1	4.27132	-.97476	-.50706	---	+.66102	+.29362	+.67334	-1.17286	-1.06886	.93286	---	---
	(16.02)	(-7.09)	(-3.48)		(2.73)	(2.90)	(1.93)	(-2.78)	(-2.73)	(1.99)		
2	4.36052	-.83184	-.35534	---	---	+.38832	---	-1.56888	---	+.9721	---	---
	(24.98)	(-7.02)	(-3.05)			(4.45)		(-4.18)		(2.37)		
3	-1.34832	-1.05848	-.40798	+.78690	---	---	---	---	-1.26042	+1.85736	---	+.77738
	(-7.11)	(-6.29)	(-1.86)	(2.83)					(-2.66)	(3.67)		(3.20)
4	2.16274	-.74118	-.29584	+.43348	+.61436	+.18334	---	---	-.95946	---	1.03948	---
	(17.88)	(-8.69)	(-3.12)	(2.91)	(3.29)	(2.74)			(-3.42)		(3.21)	

Table 7

Multivariate Logit Equations

for Large Trout by Cluster

Cluster	Constant	DOLDBLE1	STRPSHM	DYSFSHED	COMPARE	TCOMPARE	LRGCOT	RVRMAIN	REASON03	REASON06	INCOME	HRSDAY
1	5.41962	-1.26368	---	+1.1819	-.93696	-1.00908	+.25018	+1.20032	---	---	---	---
	(20.52)	(-7.70)		(4.36)	(-2.10)	(-2.52)	(2.27)	(1.96)				
2	7.07974	-1.55158	-.4734	+1.44	---	-.85084	-.2029	---	---	-.75128	---	---
	(18.53)	(-8.44)	(-3.04)	(4.40)		(-2.05)	(1.88)			(-1.99)		
3	-.68532	-1.28872	---	+.91684	---	---	---	+1.27934	+1.70674	---	+.47326	+.60614
	(-6.70)	(-6.81)		(2.54)				(1.91)	(2.16)		(1.86)	(1.65)
4	4.00282	-1.36095	-.3364	+.80248	---	-1.05902	+.17136	+1.53576	---	---	+.77024	---
	(16.60)	(-10.96)	(-3.00)	(3.56)		(-3.21)	(2.06)	(3.84)			(4.24)	

Table 8

Multivariate Logit Equations

for Doubled Catch by Cluster

Cluster	Constant	DOLDBLE2	STRPSHM	DYSFSHED	COMPARE	TCOMPARE	LRGCOT	RVRMAIN	REASONO3	DYSFSHYR	INCOME	EDUCATE
1	3.28458	-1.08384	-.48714	---	-.82186	---	+.35932	---	---	.68604	---	---
	(15.80)	(-9.65)	(-3.17)		(-2.02)		(3.76)			(3.16)		
2	4.61944	-1.30546	-.26844	+.78262	---	---	+.35896	---	---	---	---	---
	(22.45)	(-7.94)	(-2.12)	(2.94)			(3.70)					
3	1.25672	-1.29072	---	+.8775	---	---	---	---	+1.65268	---	.66666	-1.3147
	(6.64)	(-6.65)		(2.51)					(2.06)		(2.28)	(-1.94)
4	2.2427	-1.08772	-.65326	+.97306	---	-.81812	+.12862	+.58336	---	.35736	+.605	---
	(13.54)	(-9.77)	(5.31)	(4.68)		(-2.56)	(1.65)	(1.66)		(2.31)	(3.56)	

Table 9

Open CVM Equations by Cluster Grouping: Current Conditions

Cluster	Constant	DYSFSHED	STRPSHM	HRSDAY	DYSFSHYR	YRSFSHRV	TROUTCOT	RVRMAIN	REASON03	REASON06	TCOMPARE	INCOME	AGE	YRSFSH
1	1.223513	+.481479	-.442645	---	+.423587	---	---	+.701112	---	---	-.639577	+.378722	---	---
	(2.32)	(4.21)	(-4.57)		(3.34)			(2.11)			(-3.10)	(3.14)		
Observations: 160			$\bar{R}^2$: .349	F: 15.202										
2	4.791186	+.454711	-.329898	---	---	---	+.180481	---	-.36076	-.378295	-.863802	---	---	-.258574
	(10.45)	(3.12)	(-4.87				(3.18)		(-1.81)	(-2.10)	(-4.38)			(-2.16)
Observations: 170			$\bar{R}^2$: .426	F: 18.905										
3	1.256901	+.481243	---	+.350676	---	-.267029	---	---	---	---	---	+.334022	---	---
	(2.75)	(3.05)		(1.90)		(-2.89)						(2.51)		
Observations: 92			$\bar{R}^2$: .206	F: 6.904										
4	3.363543	+.752685	-.210182	+.474606	---	---	---	.559308	---	---	-.551225	+.355129	-.512071	---
	(4.47)	(6.99)	(-3.64)	(3.42)				(2.60)			(-3.35)	(3.34)	(-2.59)	
Observations: 291			R^2: .393	F: 27.864										

Table 10

Open CVM Equations by Cluster Grouping: Large Trout

Cluster	Constant	DISFSFED	STRPSHM	HRSDAY	DISFSHIR	YRSFSHRV	TROUTCOT	TROUTKPT	LRGCOT	RVRMAIN	REASON	REASON03	REASON06	COMPARE	TCOMPARE	INCOME	YRSFSH
1	1.079315	+.233985	-.270036	---	+.268821	---	---	---	+.138938	---	---	---	---	---	---	+.417632	---
	(2.32)	(2.25)	(-3.25)		(2.54)				(2.87)							(3.70)	
Observations: 189	$\bar{R}^2$: .196	F: 10.177															
2	3.040616	+.645574	-.273631	+.347765	---	---	---	---	---	---	---	---	-.597196	-.403154	---	---	---
	(7.83)	(5.55)	(-4.19)	(2.05)									(-3.33)	(-1.99)			
Observations: 190	$\bar{R}^2$: .335	F: 20.05															
3	1.780536	+.439247	---	---	---	-.324339	+.116437	---	---	---	---	---	---	---	---	---	+.331981
	(4.86)	(2.61)				(-2.87)	(2/03)										(2.29)
Observations: 98	$\bar{R}^2$: .179	F: 6.067															
4	1.464585	+.633416	---	+.382976	---	-.240761	+.105412	-.076604	---	+.553101	+.311145	-.448656	---	---	-.263991	+.278859	+.23218
	(3.09)	(5.77)		(2.67)		(-3.51)	(2.53)	(-2.02)		(2.90)	(1.92)	(-2.43)			(-1.78)	(3.10	(2.20)
Observations: 298	$\bar{R}^2$: .394	F: 18.575															

Table 11

Open CVM Equations by Cluster Grouping: Double Catch

Cluster	Constant	DYSFSHED	STRPSHM	HRSDAY	DYSFSHYR	YRSFSHRV	TROUTCOT	TROUTKPT	LRGCOT	RVRMAIN	REASON	REASON03	REASON06	TCOMPARE	INCOME
1	1.294052	+.307434	-.263933	---	+.219770	---	---	---	+.203708	---	---	---	---	---	+.450504
	(2.98)	(2.93)	(-3.34)		(2.13)				(4.39)						( )
Observations: 183			$\bar{R}^2$: .288	F: 15.737											
2	4.188078	+.630893	-.170929	---	---	-.182598	---	---	+.12721	+.987953	-.622238	-.344599	-.51329	-.457288	---
	(14.85)	(4.57)	(-2.63)			(-2.19)			(2.52)	(3.44)	(-2.31)	(-1.81)	(-2.93)	(-2.48)	
Observations: 182			$\bar{R}^2$: .440	F: 16.808											
3	1.710685	+.57875	---	---	---	---	+.234056	---	-.148838	---	---	---	---	---	---
	(10.23)	(3.37)					(3.61)		(-1.92)						
Observations: 97			$\bar{R}^2$: .222	F: 10.147											
4	2.044087	+.744214	-.133661	+.261839	---	---	---	-.068932	---	---	---	-.52049	---	---	+.331344
	(4.90)	(6.73)	(-2.56)	(2.00)				(-1.82)				(-2.86)			(3.78)
Observations: 276			$\bar{R}^2$: .339	F: 24.631											

Table 12

Multivariate Logit Equations
for Current Conditions by River

River	Constant	DOLAMT	STRPSHM	DYSFSHED	COMPARE	TCOMPARE	LRGCOT	RVRMAIN	REASON	AGE	EDUCATE	INCOME
1	3.62584	-.58374	---	---	---	-1.72972	+.45354	+2.36180	---	-1.11842	---	.96648
	(5.84)	(-3.04)				(-2.74)	(2.83)	(3.02)		(-1.73)		(2.37)
2	-1.26466	-.45052	---	+.92102	---	---	---	---	---	---	---	.76842
	(8.27)	(-3.33)		(2.82)								(2.51)
3	-.74750	-.74204	-.51088	---	---	---	+.63160	---	---	---	+2.41168	---
	(6.09)	(-4.08)	(-2.56)				(3.65)				(2.78)	
4	-3.53808	-.57130	---	---	---	---	---	---	+1.01818	+1.38334	---	---
	(3.23)	(-3.15)							(1.85)	(2.42)		
5	.57570	-.64862	---	---	-1.61220	---	---	---	---	---	---	+.8650
	(6.73)	(-2.91)			(-2.01)							(1.88)
6	1.72320	-.76158	-.39408	---	-1.37850	---	+.32924	---	---	---	---	+.77538
	(8.67)	(-4.66)	(-2.28)		(-2.47)		(2.92)					(2.40)
8	-2.58064	-.58682	---	+.63220	---	---	---	---	---	---	---	+1.02986
	(5.92)	(-3.51)		(1.81)								(2.78)
10	6.03022	-1.03866	-.48340	+1.47056	---	---	---	---	---	-1.55814	+2.20118	---
	(5.57)	(-2.98)	(-1.77)	(2.27)						(-1.87)	(1.76)	
12	1.98104	-.43298	-.38362	+1.35656	---	---	+.37340	---	---	---	---	---
	(17.10)	(2.82)	(-2.38)	(2.68)			(2.71)					

Table 12

(continued)

River	Constant	DOLAMT	STRPSHM	DYSFSHED	COMPARE	TCOMPARE	LRGCOT	RVRMAIN	REASON	AGE	EDUCATE	INCOME
13	-.46636	-.87392	-.62486	---	---	-2.06522	---	---	---	---	3.33846	---
	(4.42)	(-3.38)	(-2.18)			(-2.33)					(2.66)	
14	8.99468	-1.16828	---	+.63690	-1.20044	---	+.29076	---	---	---	-3.25892	+.65322
	(7.69)	(-5.33)		(1.84)	(-1.95)		(2.09)				(-2.95)	(1.70)
15	2.55158	-1.62826	---	---	---	---	+.32268	---	---	---	---	+.90212
	(8.75)	(-5.96)					(3.77)					(2.24)
16	1.40974	-.98736	---	---	-2.77338	---	---	---	---	---	---	+1.06146
	(7.34)	(-3.97)			(-3.21)							(2.25)
17	3.45280	-.85354	---	+1.62224	-2.07864	---	---	---	---	---	---	---
	(10.24)	(-2.43)		(2.05)	(-2.07)							
18	3.95316	-.97656	---	+2.23262	---	-2.43306	---	+2.42668	---	---	---	---
	(13.45)	(-4.34)		(3.72)		(-3.11)		(2.50)				
20	3.68796	-.71842	-.46290	---	---	---	+.33810	---	---	---	---	---
	(17.10)	(-4.00)	(-2.73)				(2.47)					
21	5.41720	-.76416	---	+.51848	---	---	---	---	---	-1.07640	---	---
	(7.26)	(-4.01)		(1.77)						(-1.91)		

Table 13

Multivariate Logit Equations

for Large Trout by River

River	Constant	DOLDBLE1	STRPSHM	DYSFSHED	COMPARE	TCOMPARE	LRGCOT	REASON	RVRMAIN	REASON06	INCOME	EDUCATE	AGE
1	5.68108	-1.40302	---	+2.07812	---	-1.69640	---	---	+1.15495	---	---	---	---
	(13.09)	(-4.69)		(3.43)		(-2.40)			(2.81)				
2	8.64432	-1.41618	---	+1.12346	---	---	+.61776	+1.71504	+1.36598	---	---	-1.4558	---
	(9.97)	(-5.46)		(2.60)			(3.18)	(2.58)	(1.77)			(-1.83)	
3	-.33790	-1.03082	---	+1.52038	---	---	+.39406	---	---	---	+1.27972	---	---
	(8.67)	(-4.57)		(2.99)			(2.23)				(3.29)		
4	4.53584	-1.09846	---	1.47748	---	---	---	---	---	-1.73348	---	---	---
	(12.95)	(-4.48)		(2.42)						(-2.70)			
5	-.35780	-1.23050	---	---	---	---	---	---	---	-1.54472	+1.62704	-3.25058	+1.96482
	(2.31)	(-3.14)								(-1.69)	(2.21)	(-2.18)	(1.89)
6	5.08238	-2.17004	-.50552	+1.85002	-2.29148	---	+.52178	+2.45166	---	---	+1.52030	---	---
	(7.54)	(-5.44)	(-1.91)	(2.66)	(-2.49)		(2.70)	(2.08)			(3.15)		
8	3.25760	-1.99372	---	+.87644	-1.67792	---	---	+1.91318	---	---	1.11698	---	---
	(7.82)	(-5.48)		(1.71)	(-2.19)			(2.23)			(2.54)		
10	1.23754	-.84776	---	+1.26162	---	---	---	---	---	-1.56576	---	+1.81858	---
	(7.18)	(-3.22)		(2.49)						(-2.21)		(1.72)	
12	4.47990	-1.13218	-.57364	---	---	---	---	---	+2.03726	---	---	---	---
	(16.98)	(-5.36)	(-2.95)						(2.76)				

Table 13

(continued)

River	Constant	DOLDBLE1	STRPSHM	DYSFSHED	COMPARE	TCOMPARE	LRGCOT	REASON	RVRMAIN	REASON06	INCOME	EDUCATE	AGE
13	4.21932	-.78054	-.46124	---	---	---	+.38068	---	---	---	---	---	---
	(11.95)	(-3.36)	(-2.06)				(1.85)						
14	5.13056	-1.02160	-.37596	+1.03954	-.91208	---	---	---	---	---	---	---	---
	(15.32)	(-5.28)	(-1.94)	(2.99)	(-1.67)								
15	.7024	-1.01152	---	+1.29566	---	---	---	---	---	---	---	1.47212	---
	(8.33)	(-5.24)		(3.61)								(2.10)	
16	2.99016	-1.87662	---	-1.59048	---	---	---	---	+2.99360	---	+2.99360	---	---
	(6.98)	(-4.08)		(2.27)					(2.49)		(2.49)		
17	7.35762	-1.85670	---	+2.16270	-2.70692	---	---	---	---	---	---	---	---
	(7.15)	(-3.32)		(2.68)	(-2.32)								
18	9.09974	-1.32096	---	+1.78934	---	---	---	---	+2.07340	---	---	---	-1.37204
	(7.55)	(-5.05)		(2.67)					(1.87)				(-2.26)
20	2.44384	-1.02910	-.33890	---	---	---	+.44296	---	---	---	+.85656	---	---
	(7.55)	(-4.68)	(-1.78)				(2.41)				(2.12)		
21	8.28240	-1.42862	---	+.77958	---	---	+.40064	---	---	---	---	-2.29538	---
	(9.17)	(-4.53)		(2.18)			(1.86)					(-2.34)	

Table 14

Multivariate Logit Equations for Doubled Catch by River

River	Constant	DOLDBLE2	STRPSHM	DYSFSHED	COMPARE	TCOMPARE	LRGCOT	TROUTCOT	REASON	RVRMAIN	REASON03	INCOME	EDUCATE	AGE
1	4.8926	-1.45268	---	---	-2.11996	-2.08042	+.3714	---	+2.8855	+2.31872	-1.64504	+1.3532	---	---
	(8.52)	(-4.40)			(-2.61)	(-2.51)	(2.20)		(2.93)	(2.62)	(-2.25)	(2.80)		
2	1.44026	-1.10002	-.48774	---	---	---	+.51646	---	---	+1.6816	---	+1.06706	---	---
	(8.32)	(-4.72)	(-2.30)				(3.20)			(2.25)		(2.66)		
3	-1.01812	-.70678	---	+2.02452	---	---	---	---	---	---	+1.06954	+.64948	---	---
	(6.47)	(-3.40)		(2.99)							(1.67)	(1.81)		
4	3.15424	-.79034	---	+1.4942	---	---	---	---	---	---	-1.2394	---	---	---
	(13.93)	(-3.70)		(3.12)							(-1.78)			
5	5.22722	-.69068	---	---	-2.16048	---	---	---	---	---	---	+1.00924	-2.29228	---
	(6.38)	(-2.88)			(-2.14)							(1.81)	(-1.82)	
6	1.56544	-.85314	---	---	---	---	+.44674	---	---	---	---	+1.1881	-1.39168	---
	(8.63)	(-5.18)					(3.61)					(3.34)	(-1.80)	
8	3.51398	-.9794	-.46808	---	---	---	+.31932	+.3132	---	---	---	---	---	---
	(14.79)	(-4.37)	(-2.20)				(1.93)	(1.90)						
10	1.30066	-.46682	---	+1.52598	---	---	---	---	---	---	---	---	---	---
	(16.45)	(-2.37)		(2.78)										

Table 14

(continued)

River	Constant	DOLDBLE2	STRPSHM	DYSFSHED	COMPARE	TCOMPARE	LRGCOT	TROUTCOT	REASON	RVRMAIN	REASON03	INCOME	EDUCATE	AGE
12	3.6835	-1.02698	---	---	-1.59132	---	---	+.3872	---	+2.16424	---	---	---	---
	(16.21)	(-5.25)			(-2.65)			(2.62)		(3.35)				
13	6.61276	-1.54326	-.6877	---	---	---	---	---	---	---	---	---	---	---
	(9.94)	(-4.02)	(-2.44)											
14	6.05246	-1.5041	-.43244	+1.2682	-1.74468	---	---	+.43918	---	---	---	---	---	---
	(14.68)	(-5.99)	(-2.14)	(3.10)	(-2.92)			(2.58)						
15	3.77136	-1.20552	---	1.0350	---	---	+.25104	---	---	---	---	---	---	---
	(18.31)	(-5.48)		(2.73)			(1.84)							
16	-.82594	-2.6274	-.71662	+2.4874	---	---	---	---	---	+2.20652	---	---	---	+2.4714
	(-1.83)	(-3.75)	(-1.70)	(3.17)						(1.95)				(1.75)
17	11.07916	-2.18984	---	+3.93058	-2.8383	-4.03884	---	---	---	---	---	---	---	---
	(5.06)	(-2.78)		(2.43)	(-2.05)	(-2.02)								
18	3.12316	-1.18032	---	+1.57036	---	---	---	---	---	+2.32246	---	---	---	---
	(16.01)	(-4.76)		(3.32)						(2.19)				
20	4.46628	-.93938	-.50760	---	---	---	+.39054	---	---	---	---	---	---	---
	(16.06)	(-4.34)	(-2.88)				(2.77)							

Table 14

(continued)

River	Constant	DOLDBLE2	STRPSHM	DYSFSHED	COMPARE	TCOMPARE	LRGCOT	TROUTCOT	REASON	RVRMAIN	REASONO3	INCOME	EDUCATE	AGE
21	2.3014	-.8715	---	+.88294	---	---	---	---	---	---	---	---	---	---
	(16.66)	(-3.90)		(2.48)										

Table 15

Sample Size for Logit by River

		Bid Equation		
River Code	River Name	Current Conditions	Large Trout	Double Catch
1	Beaverhead	108	113	104
2	Big Hole	140	148	132
3	Bitterroot	117	112	102
4	Blackfoot	97	94	94
5	Boulder	69	67	69
6	Bighorn	151	147	152
7	Upper Clark Fork	29 *	29 *	29 *
8	Clark Fork	126	126	130
10	Flathead	65	68	72
11	South Fork of Flathead	11 *	11 *	11 *
12	Gallatin	152	147	143
13	Kootenai	72	73	70
14	Madison	155	167	161
15	Missouri	148	158	151
16	Rock Creek	78	75	72
17	Smith	44	46	44
18	Stillwater	113	115	110
20	Upper Yellowstone	121	115	123
21	Middle Yellowstone	105	98	95

* Estimate did not converge.

Table 16

Open CVM Equations by River: Current Conditions

River	Constant	DYSFSHED	STRPSEM	HRSDAY	DYSFSHYR	YRSFSHRV	YRSFSH	TROUTCOT	TROUTKPT	RVRMAIN	REASON	REASON03	REASON06	TCOMPARE	INCOME	AGE	EDUCATE
1	2.323228	+1.205624	---	---	---	---	---	---	-.187806	+1.466443	---	---	---	-.695381	---	---	---
	(7.65)	(4.23)							(-2.04)	(3.24)				(-1.93)			
	Observations: 57		$\bar{R}^2$: .402	F: 10.392													
2	-.111898	+.73807	---	---	---	---	---	---	---	+1.360363	---	---	---	---	---	---	---
	(-1.68)	(3.52)								(3.33)							
	Observations: 65		$\bar{R}^2$: .308	F: 10.5													
3	2.141177	---	---	---	---	---	---	+.377787	---	---	+.966628	---	---	---	---	---	---
	(10.67)							(3.70)			(1.92)						
	Observations: 40		$\bar{R}^2$: .253	F: 7.599													
4	-.661994	---	---	+.823252	+.578794	---	---	---	+.229141	---	---	---	---	---	---	---	---
	(-.895)			(1.95)	(3.15)				(2.50)								
	Observations: 42		$\bar{R}^2$: .319	F: 7.411													

Table 16

(continued)

River	Constant	OYSFSHED	STRPSHM	HRSDAY	OYSFSHYR	YRSFSHRV	YRSFSH	TROUTCOT	TROUTKPT	RVRMAIN	REASON	REASON03	REASON06	TCOMPARE	INCOME	AGE	EDUCATE
5	.202006	+.583541	-.523989	---	---	---	---	---	---	-1.381361	---	---	---	---	+1.015517	---	---
	(.275)	(2.21)	(-2.83)							(-2.69)					(4.39)		
	Observations: 33		$\bar{R}^2$: .683	F: 18.242													
6	3.724872	+1.172372	-.281662	---	---	---	---	---	---	---	---	---	---	-.46254	---	---	---
	(13.75)	(6.17)	(-3.43)											(-2.08)			
	Observations: 85		$\bar{R}^2$: .480	F: 26.859													
7	-.196679	---	---	+1.594851	---	---	---	---	---	---	---	---	---	---	---	---	---
	(-.18)			(1.91)													
	Observations: 11		$\bar{R}^2$: .210	F: 3.662													
8	3.680271	+.691543	---	---	---	---	-.67509	---	---	---	---	---	---	---	+.569396	---	-.665611
	(3.08)	(3.17)					(-2.80)								(2.55)		(-1.69)
	Observations: 54		$\bar{R}^2$: .271	F: 5.914													

Table 16

(continued)

River	Constant	OYSFSHEO	STRPSHM	HRSDAY	OYSFSHYR	YRSFSHRV	YRSFSH	TROUTCOT	TROUTKPT	RVRMAIN	REASON	REASCNO3	REASON06	TCOMPARE	INCOME	AGE	EDUCATE
10	3.593903	---	-.838787	---	+1.031396	---	---	---	---	---	---	---	---	---	---	-1.611449	-1.905326
	(2.31)		(-5.18)		(3.82)											(-4.03)	(2.79)
	Observations: 24		$\bar{R}^2$: .698	F: 14.272													
12	2.306052	+1.260004	---	---	---	---	---	---	---	+1.060127	---	---	---	---	---	---	---
	(17.84)	(2.88)								(3.28)							
	Observations: 69		$\bar{R}^2$: .289	F: 14.835													
13	2.633168	+.1430232	---	---	---	---	---	---	---	---	---	---	---	-.777625	---	---	---
	(10.32)	(4.44)												(-2.77)			
	Observations: 32		$\bar{R}^2$: .489	F: 15.855													
14	1.855164	+.82921	---	+.596732	---	---	+.296716	---	---	+.822016	---	-.873937	---	---	---	---	---
	(2.18)	(5.44)		(1.98)			(2.01)			(2.69)		(-2.66)					
	Observations: 75		$\bar{R}^2$: .545	F: 18.703													

Table 16

(continued)

River	Constant	OYSFSHED	STRPSHM	HRSDAY	OYSFSHYR	YRSFSHRV	YRSPSH	TROOTCOT	TROOTKPT	RVRMAIN	REASON	REASON03	REASON06	ICOMPARE	INCOME	AGE	EDUCATE
15	2.700073	+.855312	---	---	---	-.247383	---	---	---	---	---	+1.136422	-1.027966	---	---	---	---
	(5.57)	(4.08)				(-1.96)						(2.59)	(-3.10)				
	Observations: 94		$\bar{R}^2$: .215	F: 7.370													
16	2.26463	---	---	+.783672	---	---	---	---	---	---	---	---	-1.125425	---	---	---	---
	(4.86)			(2.92)									(-3.71)				
	Observations: 40		$\bar{R}^2$: .307	F: 9.630													
17	.541342	---	---	+.436208	---	+.391943	---	---	---	-1.586265	---	---	+1.472358	---	---	---	---
	(1.398)			(2.17)		(3.94)				(-3.47)			(5.92)				
	Observations: 16		$\bar{R}^2$: .816	F: 17.678													
18	4.532665	---	-.307883	---	---	---	---	---	---	---	+.696985	---	---	-1.822189	---	---	---
	(7.59)		(-1.88)								(1.70)			(-3.91)			
	Observations: 46		R^2: .304	F: 7.538													

Table 16

(continued)

River	Constant	OYSFSREQ	STRPSRM	HRSOAT	OYSFSHYR	YRSFSRRV	YPSFSH	TROOTCOT	TROOTKPT	RVRMAIN	REASON	REASON03	REASON06	TCOMPARE	INCOME	AGE	EDUCATE
20	4.288664	---	-.341202	---	---	---	---	+.255851	---	---	---	-1.083329	---	---	---	---	---
	(7.81)		(-2.91)					(2.37)				(-2.30)					
	Observations: 54		R^2: .321	F: 9.367													
21	2.549081	+.535398	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	(16.98)	(4.06)															
	Observations: 43		$\bar{R}^2$: .269	F: 16.470													

Table 17

Open CVM Equations by River: Large Trout

River	Constant	DYSFSHED	STRPSHM	RRSDAY	YRSFSHRV	YRSFSH	TROUTCOT	TROUTKPT	LRGCOT	RVRMAIN	REASON	REASON03	REASON06	CCMPARE	TCOMPARE	INCOME	AGE	EDUCATE
1	2.667747	+.825127	---	+.61342	-.369887	---	---	-.249038	+.284286	+1.72614	+1.295923	---	---	---	-.982193	---	---	---
	(4.12)	(3.39)		(2.22)	(-3.04)			(-3.92)	(3.97)	(5.29)	(3.26)				(-3.26)			
	Observations: 64		$\bar{R}^2$: .680	F: 17.731														
2	3.843447	+.671265	---	---	-.406504	---	---	-.187968	---	+1.106323	---	---	---	---	-.467396	---	---	---
	(11.43)	(3.90)			(-4.04)			(-3.29)		(2.34)					(-1.93)			
	Observations: 70		$\bar{R}^2$: .436	F: 11.676														
3	2.46818	+.430807	---	---	---	---	.210861	---	---	---	---	---	---	---	---	---	---	---
	(15.12)	(1.95)					(2.48)											
	Observations: 54		$\bar{R}^2$: .171	F: 6.476														
4	3.150213	+.676609	---	+.623868	-.567707	+.698777	---	---	---	---	---	---	-.447397	---	---	---	---	-1.299239
	(5.06)	(4.41)		(2.63)	(-4.74)	(3.35)							(-2.00)					(-3.48)
	Observations: 50		$\bar{R}^2$: .545	F: 10.764														

Table 17

(continued)

River	Constant	DYSFSHED	STRPSHM	HRSDAY	YRSFSHRV	YRSFSH	TROUTCOT	TROUTKPT	LRGCOT	RVPMAIN	REASON	REASON03	REASON06	COMPARE	TCOMPARE	INCOME	AGE	EDUCATE
5	.364397	+.523648	---	---	---	---	---	---	-.180001	---	---	---	---	---	---	+.614196	---	---
	(.50)	(2.37)							(-1.73)							(2.95)		
	Observations: 35		$\bar{R}^2$: .421	F: 9.255														
6	1.093248	1.07588	---	+.726343	---	---	---	---	---	---	---	---	---	---	---	+.472396	---	-.643619
	(1.40)	(5.70)		(2.59)												(2.89)		(-1.88)
	Observations: 90		$\bar{R}^2$: .435	F: 18.108														
7	.306318	---	---	+1.612215	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	(.39)			(2.75)														
	Observations: 13		$\bar{R}^2$: .353	F: 7.544														
8	3.730197	---	-.289171	---	---	---	+.285574	---	---	---	---	---	---	---	---	---	---	-.565993
	(6.60)		(-2.41)				(3.54)											(-1.79)
	Observations: 61		$\bar{R}^2$: .208	F: 6.246														

Table 17

(continued)

River	Constant	DYSFSHED	STRPSHM	RRSDAY	YRSFSHRV	YRSFSH	TROUTCOT	TROUTKPT	LRGCOT	RVRMAIN	REASON	REASON03	REASON06	COMPARE	ICOMPARE	INCOME	AGE	EDUCATE (-1.79)
10	7.179874	+1.124613	---	---	---	---	---	---	---	---	---	---	---	---	---	---	-1.377352	---
	(3.40)	(2.49)															(-2.34)	
	Observations: 27		$\bar{R}^2$: .308	F: 6.784														
12	2.245088	---	---	---	---	---	---	---	---	+1.239809	+1.005233	---	---	---	---	---	---	---
	(16.71)									(4.22)	(2.80)							
	Observations: 80		$\bar{R}^2$: .231	F: 12.879														
13	4.602519	+.386478	-.506948	---	-.354911	---	---	---	+.386075	---	---	---	---	---	---	---	---	---
	(11.93)	(1.87)	(-5.96)		(-2.46)				(4.61)									
	Observations: 33		$\bar{R}^2$: .643	F: 15.389														
14	1.548634	+.893381	---	---	---	---	---	-.172198	---	+.688069	---	---	---	---	---	+.352636	---	---
	(2.28)	(4.90)						(-2.42)		(2.08)						(1.87)		
	Observations: 79		$\bar{R}^2$: .376	F: 12.767														

Table 17

(continued)

River	Constant	OYSFSHED	STRPSHM	HRSDAY	YRSPSHRV	YRSFSH	TROUTCOT	TROUTKPT	LRGCOT	RVRMAIN	REASON	REASON03	REASON06	CCMPARE	ICOMPARE	INCOME	AGE	EDUCATE
15	1.157564	+.772459	---	---	---	---	---	---	---	---	---	+.752889	-.760204	---	---	---	---	+.705321
	(1.84)	(4.74)										(2.11)	(-2.78)					(2.13)
	Observations: 99		$\bar{R}^2$: .241	F: 8.780														
16	2.672663	+1.19237	---	---	---	---	---	---	---	+1.443411	---	---	-.572770	---	---	---	---	---
	(9.26)	(5.12)								( )			(-1.71)					
	Observations: 37		$\bar{R}^2$: .459	F: 11.198														
17	11.052019	---	+.222685	---	---	+5.06957	---	---	+.322562	---	+1.773903	---	---	-2.868355	---	---	-6.422811	---
	(21.03)		(3.62)			(34.09)			(16.27)		(9.70)			(-25.57)			(-22.70)	
	Observations: 10		$\bar{R}^2$: .996	F: 369.183														
18	2.564063	+.745848	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
	(16.10)	(3.26)																
	Observations: 47		$\bar{R}^2$: .173	F: 10.646														

Table 17

(continued)

River	Constant	DISFSHED	STRPSHM	HRSDAY	YRSFSHRV	YRSFSH	TROUTCOT	TROUTKPT	LRGCOT	RVRMAIN	REASON	REASON03	REASON06	COMPARE	TCOMPARE	INCOME	AGE	EDUCATE
20	1.690405	---	---	---	---	---	---	---	+.209394	---	---	-.775809	---	---	+.614174	+.544767	---	---
	(1.95)								(2.27)			(-2.02)			(1.71)	(2.62)		
	Observations: 67		$\bar{R}^2$: .232	F: 5.997														
21	.645308	+.522802	---	---	---	+.462869	---	---	---	---	---	---	---	+.587587	---	---	---	---
	(.898)	(4.00)				(2.34)								(1.74)				
	Observations: 44		$\bar{R}^2$: .314	F: 7.716														

Table 18

Open CVM Equations by River: Doubled Catch

River	Constant	DYSFSPED	STPPSBM	HPSDAY	DYSFSPYR	YPSFSBPY	YPSFSB	TPOUTCOT	TPOUTEPT	LRGCOT	PYRMAIN	REASON	REASON03	REASON06	COMPARE	TCOMPARE	INCOME	AGE	EDUCATE
1	2.089036 (3.29)	+1.03264 (3.55)	-.250793 (-2.04)	---	---	---	---	---	-.152729 (-1.96)	---	---	---	---	-.613596 (-2.25)	---	---	+.378874 (2.04)	---	---
	Observations: 55		$\bar{R}^2$: .503	F: 11.934															
2	3.189277 (11.68)	+.657344 (4.13)	---	---	---	-.226421 (-2.19)	---	---	---	---	+1.524771 (2.51)	---	---	---	---				
	Observations: 64		$\bar{R}^2$: .330	F: 11.33															
3	-.071948 (-.081)	---	---	+.571421 (1.73)	---	---	---	---	---	---	---	+.932128 (2.33)	---	---	---	---	---	---	+.936652 (2.00)
	Observations: 52		$\bar{R}^2$: .138	F: 3.711															
4	.989614 (2.05)	---	---	---	+.447457 (2.89)	---	---	+.322264 (3.94)	---	---	---	---	---	---	---	---	---	---	---
	Observations: 52		$\bar{R}^2$: .423	F: 19.7															

Table 18

(continued)

River	Constant	DYSFSHEO	STRPSHM	HRSDAY	DYSFSHYR	YRSFSHRV	YRSFSH	TROUTCOT	TROOTKPT	LRGCOT	RVRMAIN	REASON	REASON03	REASON06	COMPARE	TCOMPARE	INCOME	AGE	EDUCATE
5	.324433	+.649381	---	---	---	---	+.753987	---	---	---	---	+.706683	---	---	---	---	---	---	---
	(.498)	(3.22)					(3.58)					(1.79)							
	Observations: 34		$\bar{R}^2$: .472	F: 10.834															
6	2.004822	+1.048947	-.232943	---	+.363247	---	---	---	-.099554	+.097397	---	---	---	---	---	-.382141	+.537011	---	-.901842
	(3.30)	(5.51)	(-2.80)		(3.16)				(-2.06)	(2.03)						(-1.97)	(4.08)		(-3.30)
	Observations: 83		$\bar{R}^2$: .675	F: 22.261															
7	8.730448	---	---	---	---	---	+1.590791	---	+.570765	---	---	---	-2.608257	-1.474757	---	---	---	-2.158121	---
	(3.70)						(4.34)		(4.53)				(-7.58)	(-3.32)				(-2.44)	
	Observations: 13		$\bar{R}^2$: .87	F: 17.034															
8	2.151755	+.420056	-.533871	+.877824	---	---	-.483495	---	---	---	---	---	---	---	---	---	+.505555	---	---
	(2.55)	(2.52)	(-4.71)	(3.92)				(-2.86)									(3.13)		
	Observations: 55		$\bar{R}^2$: .476	F: 10.828															

Table 18

(continued)

River	Constant	DISFSRED	STRPSRM	HRSDAY	DISFSRYR	IRSFSRRV	YRSFSR	TROOTCOT	TROUTKPT	LRGCOT	RVRMAIN	REASON	REASON03	REASON06	COMPARE	TCOMPARE	INCOME	AGE	EDUCATE
10	4.86819	+2.134017	---	---	---	---	---			---	---	---	---	---	---	---	---	-1.481	+1.69114
	(2.46)	(3.47)																(-2.67)	(1.77)
	Observations: 24		$\bar{R}^2$: .525	F: 9.484															
12	2.272791	---	---	---	---	---	---	---	---	---	+1.159162	+.7064	---	---	---	---	---	---	---
	(17.44)										(4.29)	(2.08)							
	Observations: 70		$\bar{R}^2$: .225	F: 11.042															
13	4.67361	---	-.420835	---	---	-.356138	---	---	---	+.45787	---	---	---	---	---	---	---	---	---
	(14.52)		(-5.89)			(-3.02)				(6.36)									
	Observations: 36		$\bar{R}^2$: .621	F: 20.119															
14	2.286679	---	-.651655	---	+.354987	---	---	---	---	---	---	---	-.880866	---	---	-.940758	+.643415	---	---
	(2.21)		(-5.29)		(2.07)								(-2.61)			(-2.99)	(3.15)		
	Observations: 79		$\bar{R}^2$: .438	F: 13.154															

Table 18

(continued)

River	Constant	DYSFSHED	STRPSHN	HRSDAY	DYSFSHYR	YRSFSHRV	YRSFSH	TROOTCOT	TROOTKPT	LRGCOT	RVRMAIN	REASON	REASON03	REASON06	COMPARE	TCOMPARE	INCOME	AGE	EDUCATE
15	3.230112	+.581344	-.278607	---	---	---	---	---	---	+.158686	---	---	---	---	---	---	---	---	---
	(12.33)	(2.94)	(-2.72)							(2.09)									
	Observations: 95		$\bar{R}^2$: .231	F: 10.411															
16	2.706172	+.812706	---	---	---	---	---	---	---	---	+1.338204	---	---	-.699479	---	---	---	---	---
	(11.46)	(4.30)									(3.27)			(-2.61)					
	Observations: 39		$\bar{R}^2$: .439	F: 10.897															
17	4.852212	---	---	---	---	---	+2.747842	+.183375	---	---	---	---	---	---	-2.113021	---	---	-2.718172	---
	(5.79)						(10.44)	(3.97)							(-9.70)			(-7.29)	
	Observations: 11		$\bar{R}^2$: .951	F: 50.003															
18	7.61109	---	-.770289	---	---	---	---	---	+.163118	---	---	---	---	---	---	+.163118	---	-.955278	---
	(8.65)		(-6.47)						(2.89)							(2.89)		(-4.25)	
	Observations: 48		$\bar{R}^2$: .526	F: 14.026															

Table 18

(continued)

River	Constant	DISFSHED	STRPSRM	HRSDAY	DISFSHYR	YRSFSHRV	YRSFSH	TROUTCOT	TROUTKPT	LRGCOT	RVRMAIN	REASON	REASON03	REASON06	COMPARE	ICOMPARE	INCOME	AGE	EDUCATE
20	.837293 (1.02)	---	---	---	---	-.567444 (-2.92)	+.871506 (3.93)	---	---	+.195457 (2.32)	---	---	-.884461 (-2.52)	---	---	---	+.526302 (2.58)	---	---
	Observations: 61		$\bar{R}^2$: .440	F: 10.425															
21	1.771724 (5.17)	+.527905 (3.45)	---	---	---	---	---	---	---	+.176806 (1.92)	---	---	---	---	---	+.901912 (2.38)	---	---	---
	Observations: 50		$\bar{R}^2$: .308	F: 8.259															

Table 19

Logit Estimated
Net Economic Value Per Trip
Complete Sample

Bid Question	Mean	Median	Sample Size
Current Conditions	90.94	24.51	1751
Double Catch of Large Trout	101.77	48.04	1719
Double Catch	97.52	36.07	1749

Note: Mean integration estimate truncated at $500 (maximum observed "yes" response and maximum bid asked).

Table 20

Summary of Open CVM Statistics for Complete Sample

Statistic	Variable Current Conditions	 Large Trout	 Double Catch
Mean	28.54	28.82	26.64
Standard error	2.55	2.04	1.91
Observations	2110	2122	2120
Median	5	5	5
Range	2500	2500	2000
Percent Zero	46.1	39.5	42.5
Mode	0	0	0
Kurtosis	235.53	259.05	181.52
Skewness	13.17	12.66	10.95

Notes: Excluded observations: bid values coded 9999 and protest responses (WHYZEROj = 3 or 4 or 5).

Where: Current conditions = WTP for current conditions.

Large trout = WTP to double chance of large trout.

Double catch = WTP to double total catch.

Table 21

Influence of Selected Subsamples on Open CVM Mean Willingness-to-Pay

Statistic	Subsample				
	Complete	Not 9999	Not 0	0<Resp<=500	TCM
Current Conditions:					
Observations	2183	2182	1105	1096	956
Mean	32.20	27.63	52.18	41.70	23.59
Standard error	5.19	2.47	4.62	2.31	3.25
Large Trout:					
Observations	2183	2182	1233	1227	956
Mean	32.67	28.10	47.68	41.96	26.45
Standard error	4.98	1.99	3.33	2.07	5.50
Doubled Catch:					
Observations	2183	2182	1168	1162	956
Mean	30.53	25.96	46.17	40.64	22.20
Standard error	4.93	1.85	3.26	2.12	2.31

Notes: Subsamples are:
Not 9999 excludes bid values coded 9999.
Not 0 excludes zero value responses.
0<Resp<=500 excludes responses equal to zero and greater than 500.
TCM is the subsample that would be used in a travel cost model and includes only main purpose and single destination trips.

Table 22

Logit by Cluster

Net Economic Values per Trip

Cluster	Bid Variable: Current Conditions	Large Trout	Double Catch
Median Values:			
1 Generalist	31.42	56.10	41.47
2 Generalist	34.40	49.38	38.43
3 Occasional User	1.42	30.23	18.67
4 Specialist	72.03	105.91	74.03
Mean Values:			
1 Generalist	91.03	110.54	99.96
2 Generalist	117.07	86.46	80.81
3 Occasional User	7.56	67.51	45.26
4 Specialist	170.28	166.75	145.56

Notes: Mean values based on integration truncated at maximum observed "yes" response by cluster ($500 in all cases).
Current Conditions = bid for current conditions.
Large Trout = bid for double chance of large trout catch.
Double Catch = bid to double catch.
Sample size for Current Conditions:
Cluster: 1 = 294, 2 = 319, 3 = 211, 4 = 546;
Large Trout: 1 = 296, 2 = 314, 3 = 218, 4 = 550;
Double Catch: 1 = 297, 2 = 310, 3 = 207, 4 = 529.

Table 23

Open-Ended CVM Mean Bids by Cluster

Complete Sample

Bid Question	Cluster	Mean	Median	Std. Error	n
Current Conditions	1	29.028	5.00	9.116	288
	2	28.327	5.00	4.954	309
	3	9.482	0.00	1.543	232
	4	40.144	8.00	4.321	585
Large Trout	1	25.965	10.00	8.767	288
	2	30.265	10.00	4.775	309
	3	9.44	1.00	1.796	232
	4	43.202	10.00	3.969	585
Double Catch	1	26.215	10.00	5.986	488
	2	31.061	10.00	5,100	309
	3	8.444	0.00	1.343	232
	4	38.154	10.00	4.570	585

Notes: Excluded observations: bid values coded 9999 and protest responses (WHYZEROj = 3 or 4 or 5).

Where: Current Conditions = WTP for current conditions.
Large Trout = WTP to double chance of large trout.
Double catch = WTP to double total catch.

Table 24

Open-Ended Cum. Mean Bids by Cluster Group

Response Not Equal to Zero Excluded

Response	Cluster	Mean	Median	Std. Error	n
Current Conditions	1	46.188	10	14.367	181
	2	44.658	20	7.574	196
	3	19.643	10	2.910	112
	4	66.347	20	6.792	354
Large Trout	1	35.441	10	11.908	211
	2	42.703	20	6.559	219
	3	18.644	10	3.325	118
	4	66.173	25	5.744	382
Double Catch	1	36.473	15	8.224	207
	2	46.367	20	7.389	207
	3	17.336	10	2.503	113
	4	63.771	25	7.331	350

Table 25

Open-Ended CVM Mean Bids by Cluster Group

0 < Response <= 500

Response	Cluster	Mean	Median	Std. Error	n
Current Conditions	1	32.556	10	4.561	180
	2	39.759	20	5.805	195
	3	19.643	10	2.910	112
	4	55.980	20	4.925	349
Large Trout	1	23.705	10	2.024	210
	2	38.312	20	4.894	218
	3	18.644	10	3.325	118
	4	63.197	25	4.926	381
Double Catch	1	26.585	12	3.110	205
	2	41.738	20	5.787	206
	3	17.336	10	2.503	113
	4	58.223	25	4.805	349

Table 26

Logit by River: Mean Values

Bids for Current Conditions (Multivariate)

		Limit of Max "Yes" Bid Response		Limit of $500 Bid		
River Code	River Name	Max Bid	Mean	Mean	Median	Sample
1	Beaverhead	400	162.07	188.20	75.52	108
2	Big Hole	500		217.77	103.25	140
3	Bitterroot	250	43.43	58.83	9.19	117
4	Blackfoot	400	115.75	132.86	28.22	97
5	Boulder	250	97.39	148.75	45.30	69
6	Bighorn	500		158.50	62.97	151
8	Clark Fork	300	64.85	86.49	10.60	126
10	Flathead	300	82.49	99.13	38.91	65
12	Gallatin	500		179.98	46.95	152
13	Kootenai	500		38.13	7.01	72
14	Madison	400	203.98	228.12	168.34	155
15	Missouri	300	58.55	62.53	35.54	148
16	Rock Creek	250	70.92	92.17	32.62	78
17	Smith	150	77.96	152.87	65.32	44
18	Stillwater	400	78.49	84.87	28.30	113
20	Upper Yellowstone	300	112.13	150.25	52.57	121
21	Middle Yellowstone	200	48.84	74.35	14.76	105

Table 27

Logit by River: Mean Values

Bids for Large Trout

	Limit of Maximum "Yes Bid Response		Limit of $500 Bid		
River	Max Bid	Mean	Mean	Median	Sample
1	500		173.27	113.83	113
2	500		303.12	301.07	148
3	500		176.27	98.85	112
4	400	83.04	88.87	35.60	94
5	250	138.84	192.45	126.33	67
6	500		128.44	96.15	147
8	500		50.69	33.64	126
10	300	134.82	179.24	89.78	68
12	500		75.12	29.37	147
13	500		134.75	46.16	73
14	500		225.91	159.66	167
15	500		115.83	47.92	158
16	500		27.34	16.93	75
17	400	82.10	84.09	54.99	46
18	400	102.18	108.18	56.72	115
20	500		206.00	132.61	115
21	250	81.48	96.58	52.55	98

Table 28

Logit by River: Mean Values

Bids for Doubled Catch

	Limit of Maximum "Yes" Bid Response		Limit of $500 Bid		
River	**Max. Bid**	**Mean**	**Mean**	**Median**	**Size**
1	500		139.27	85.41	104
2	500		153.33	81.21	132
3	500		200.59	103.73	102
4	500		120.17	54.11	94
5	500		227.81	145.76	69
6	500		188.73	100.68	152
8	400	65.69	70.59	21.67	130
10	300	183.51	278.04	312.51	72
12	500		108.77	44.19	143
13	400	44.05	45.09	23.37	70
14	500		169.94	114.45	161
15	500		89.96	40.45	151
16	500		70.27	55.42	72
17	300	88.03	92.28	67.31	44
18	400	83.66	88.95	38.88	110
20	500		116.91	44.66	123
21	250	82.56	113.69	38.73	95

Table 29

Comparison of Bid Responses by River for Logit Method

		Logit Mean Values *		
River	River Name	Current Conditions	Large Trout	Doubled Catch
1	Beaverhead	162.07	173.27	139.27
2	Big Hole	217.77	303.12	153.33
3	Bitterroot	43.43	176.27	200.59
4	Blackfoot	115.75	83.04	120.17
5	Boulder	97.39	134.84	227.81
6	Bighorn	158.50	128.44	188.73
8	Clark Fork	64.85	50.69	65.69
10	Flathead	82.49	134.82	183.51
12	Gallatin	179.98	75.12	108.77
13	Kootenai	38.13	134.75	44.05
14	Madison	203.98	225.91	169.94
15	Missouri	58.55	115.83	89.96
16	Rock Creek	70.92	27.34	70.27
17	Smith	77.96	82.10	88.03
18	Stillwater	78.49	102.18	83.66
20	Upper Yellowstone	112.13	206.00	116.91
21	Middle Yellowstone	48.84	81.48	82.56

Difference Across Bid Questions

River	River Name	Large Trout Minus Current Conditions	Doubled Catch Minus Current Conditions
1	Beaverhead	11.20	- 22.80
2	Big Hole	85.35	- 64.44
3	Bitterroot	132.84	157.16
4	Blackfoot	- 32.71	4.42
5	Boulder	37.45	130.42
6	Bighorn	- 30.06	30.23
8	Clark Fork	- 14.16	.84
10	Flathead	52.33	101.02
12	Gallatin	- 104.86	- 71.21
13	Kootenai	96.62	5.92
14	Madison	21.93	- 34.04
15	Missouri	57.28	31.41
16	Rock Creek	- 43.58	- .65
17	Smith	4.14	10.07
18	Stillwater	23.69	5.17
20	Upper Yellowstone	93.87	4.78
21	Middle Yellowstone	32.64	33.72

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* Integration upper limit maximum "yes" bid response.

Table 30

Summary

Comparison of Median

Logit Bids by River

(Bivariate Equations)

	Significantly Different		Not Significantly Different		Missing
	Number	Percent	Number	Percent	Number
DOLDBLE1 and DOLAMT:					
Test 1	10	55	8	44	1
Test 2	6	67	3	33	10
DOLDBLE2 and DOLAMT:					
Test 1	3	20	12	80	4
Test 2	1	11	8	89	10

Where: Number = number of rivers.
Percent = percent of nonmissing rivers.
Missing = number of rivers with no confidence interval output.
DOLAMT = Bid to continue fishing the river.
DOLDBLE1 = Bid to continue fishing the river, but with doubled chance of catching large trout.
DOLDBLE2 = Bid to continue fishing the river, but with doubled catch.
Test 1 = DOLAMT compared to 95% confidence interval on DOLDBLE__.
Test 2 = DOLDBLE compared to 95% confidence interval on DOLAMT.

Table 31

Open-Ended CVM Mean Bid by River

(Excludes Protest Bids)

River	River Name	Current Conditions		Large Trout		Double Catch	
		Mean	n	Mean	n	Mean	n
1	Beaverhead	29.475	120	31.008	121	27.050	119
2	Big Hole	26.200	150	22.721	154	21.166	151
3	Bitterroot	28.888	127	24.837	129	24.434	129
4	Blackfoot	11.058	103	29.924	105	30.533	105
5	Boulder	44.078	77	29.312	77	23.857	77
6	Bighorn	38.437	167	54.331	160	50.710	162
7	Upper Clark Fork	5.457	35	11.529	34	21.294	34
8	Clark Fork	13.679	140	13.474	137	14.614	140
10	Flathead	29.914	81	25.938	81	24.173	81
11	South Fork of Flathead	11.786	14	18.929	14	24.786	14
12	Gallatin	15.510	153	24.849	159	16.025	159
13	Kootenai	11.104	77	18.127	79	16.779	77
14	Madison	52.243	177	54.774	177	54.800	175
15	Missouri	36.957	162	24.193	161	23.419	160
16	Rock Creek	13.240	100	19.152	99	16.000	101
17	Smith	35.469	49	27.32	50	16.857	49
18	Stillwater	16.315	127	15.955	132	15.451	133
20	Upper Yellowstone	60.000	138	43.212	137	37.475	139
21	Middle Yellowstone	14.119	109	13.589	112	15.018	111

Table 32

Open-Ended CVM Mean Bids by River:

Response Equal to Zero Excluded

(Summary)

River	Current Conditions Mean	Current Conditions n	Large Trout Mean	Large Trout n	Double Catch Mean	Double Catch n
1	53.591	66	48.693	75	48.694	62
2	47.349	83	37.924	92	36.988	86
3	52.931	58	44.083	72	44.632	68
4	21.491	53	36.889	63	37.391	64
5	82.780	41	50.156	45	41.750	44
6	56.327	104	76.283	113	78.865	104
7	11.938	16	19.350	20	36.200	20
8	24.694	72	22.388	80	27.444	72
10	43.906	32	51.650	40	58.727	33
11	33.000	5	33.125	8	43.375	8
12	28.590	83	34.184	103	24.287	87
13	20.238	42	30.533	45	26.367	49
14	103.337	89	97.887	97	100.978	92
15	59.870	100	36.952	105	36.686	102
16	25.600	50	35.902	51	28.060	50
17	64.000	27	67.050	20	39.550	20
18	36.268	56	35.088	57	31.274	62
20	114.264	72	69.518	85	66.649	77
21	27.036	56	22.774	62	23.044	68
All	52.176	1105	47.679	1233	46.165	1168

Table 33

Open-Ended CVM Mean Bids by River:

Response Equal to Zero Excluded

Current Conditions

River	Mean	Median	Standard Error	n
1	53.591	20	12.552	66
2	47.349	20	9.408	83
3	52.931	10	12.172	58
4	21.491	10	4.420	53
5	82.780	20	31.595	41
6	56.327	20	8.335	104
7	11.938	10	2.967	16
8	24.694	10	5.915	72
10	43.906	10	18.983	32
11	33.000	20	17.000	5
12	28.590	10	5.593	83
13	20.238	10	3.750	42
14	103.337	50	18.134	89
15	59.870	10	21.611	100
16	25.600	15	4.975	50
17	64.000	30	18.430	27
18	36.268	10	10.392	56
20	114.264	20	49.094	72
21	27.036	15	4.860	56
All	52.176	15	4.624	1105

Table 34

Open-Ended CVM Mean Bids by River: Response Equal to Zero Excluded

Large Trout

River	Mean	Median	Standard Error	n
1	48.693	25	7.652	75
2	37.924	20	4.938	92
3	44.083	17.5	9.756	72
4	36.889	15	15.761	63
5	50.156	20	15.791	45
6	76.283	25	13.901	113
7	19.350	10	5.618	20
8	22.388	10	3.485	80
10	51.650	10	24.852	40
11	33.125	21.5	11.569	8
12	34.184	10	7.153	103
13	30.533	10	5.690	45
14	97.887	50	14.603	97
15	36.952	15	7.670	105
16	35.902	20	5.206	51
17	67.050	40	24.870	20
18	35.088	20	10.697	57
20	69.518	20	29.856	85
21	22.774	15	3.188	62
All	47.679	20	3.331	1233

Table 35

Open-Ended CVM Mean Bids by River: Response Equal to Zero Excluded

Double Catch

River	Mean	Median	Standard Error	n
1	48.694	25	7.303	62
2	36.988	20	4.443	86
3	44.632	11.5	11.113	68
4	37.391	10	11.190	64
5	41.750	20	12.388	44
6	78.865	25	20.586	104
7	36.200	10	24.484	20
8	27.444	10	4.570	72
10	58.727	10	31.243	33
11	43.375	12.5	16.625	8
12	24.287	10	3.571	87
13	26.367	10	5.641	49
14	100.978	50	16.307	92
15	36.686	10	7.533	102
16	28.060	17.5	4.948	50
17	39.550	27.5	14.365	20
18	31.274	10	9.894	62
20	66.649	20	21.379	77
21	23.044	10	4.013	68
All	46.165	20	3.258	1168

Table 36

Open-Ended CVM Mean Bids by River:

0 < Response <= 500

	DOLTOGO		DBLECOT		DOLDBLCOT	
River	Mean	n	Mean	n	Mean	n
1	45.185	65	48.693	75	48.694	62
2	47.349	83	37.924	92	36.988	86
3	52.931	58	44.083	72	44.632	68
4	21.491	53	21.355	62	37.391	64
5	42.154	39	50.156	45	41.750	44
6	56.327	104	66.250	112	60.214	103
7	11.938	16	19.350	20	36.200	20
8	24.694	72	22.388	80	27.444	72
10	25.968	31	27.333	39	29.313	32
11	33.000	5	33.125	8	43.375	8
12	28.590	83	34.184	103	24.287	87
13	20.238	42	30.533	45	26.367	49
14	82.724	87	88.49	96	85.444	90
15	40.273	99	36.952	105	36.686	102
16	25.600	50	35.902	51	28.060	50
17	64.000	27	67.05	20	39.550	20
18	36.268	56	25.00	56	21.951	61
20	46.100	70	40.583	84	47.789	76
21	27.036	56	22.774	62	23.044	68
All	41.701	1096	41.963	1227	40.638	1162

Table 37

Open-ended CVM Mean Bids by River: 0 < Response <= 500

Current Conditions

River	Mean	Median	Std. Error	n
1	45.185	20	9.466	65
2	47.349	20	9.408	83
3	52.931	10	12.172	58
4	21.491	10	4.42	53
5	42.154	12	13.899	39
6	56.327	20	8.335	104
7	11.938	10	2.967	16
8	24.694	10	5.915	72
10	25.968	10	6.414	31
11	33.000	20	17.000	5
12	28.590	10	5.593	83
13	20.238	10	3.750	42
14	82.724	50	11.152	87
15	40.273	10	9.202	99
16	25.600	15	4.975	50
17	64.000	30	18.430	27
18	36.268	10	10.392	56
20	46.100	20	11.261	70
21	27.036	15	4.860	56
ALL	41.701	15	2.309	1096

Table 38

Open-ended CVM Mean Bids by River: 0 < Response <= 500

Large Trout

River	Mean	Median	Std. Error	n
1	48.693	25	7.652	75
2	37.924	20	4.938	92
3	44.083	17.5	9.256	72
4	21.355	12.5	2.711	62
5	50.156	20	15.791	45
6	66.250	25	9.707	112
7	19.350	10	5.618	20
8	22.388	10	3.485	80
10	27.333	10	5.263	39
11	33.125	21.5	11.569	8
12	34.184	10	7.153	103
13	30.533	10	5.690	45
14	88.490	50	11.295	96
15	36.952	15	7.670	105
16	35.902	20	5.206	51
17	67.050	40	24.870	20
18	25.000	20	3.624	56
20	40.583	20	7.448	84
21	22.774	15	3.188	62
ALL	41.963	20	2.071	1227

Table 39

Open-ended CVM Mean Bids by River: 0 < Response <= 500

Double Catch

River	Mean	Median	Std. Error	n
1	48.694	25	7.303	62
2	36.988	20	4.443	86
3	44.632	11.5	11.113	68
4	37.391	10	11.190	64
5	41.750	20	12.388	44
6	60.214	25	8.797	103
7	36.200	10	24.484	20
8	27.444	10	4.570	72
10	29.313	10	10.865	32
11	43.375	12.5	16.625	8
12	24.287	10	3.571	87
13	26.367	10	5.641	49
14	85.444	50	11.968	90
15	36.686	10	7.533	102
16	28.060	17.5	4.948	50
17	39.550	27.5	14.365	20
18	21.951	10	3.366	61
20	47.789	20	10.201	76
21	23.044	10	4.013	68
ALL	40.638	15	2.120	1162

Table 40

Comparison of Bid Responses by River for Open CVM Method

	Open CVM Mean Values[1]		
River	Current Conditions	Large Trout	Doubled Catch
1	53.59	48.69	48.69
2	47.35	37.92	36.99
3	52.93	44.08	44.63
4	21.49	36.89	37.39
5	82.78	50.16	41.75
6	56.33	76.28	78.87
7	11.94	19.35	36.20
8	24.69	22.39	27.44
10	43.91	51.65	58.73
11	33.00	33.13	43.38
12	28.59	34.18	24.29
13	20.24	30.53	26.37
14	103.34	97.89	100.98
15	59.87	36.95	36.69
16	25.60	35.90	28.06
17	64.00	67.05	39.55
18	36.27	35.09	31.27
20	114.26	69.52	66.65
21	27.04	22.77	23.04

[1] Excludes zero bid responses.

Table 40

(continued)

	Differences Across Bid Questions	
River	Large Trout Minus Current Conditions	Doubled Catch Minus Current Conditions
1	-4.90	-4.90
2	-9.43	-10.36
3	-8.85	-8.30
4	15.40	15.90
5	-32.62	-41.03
6	19.95	22.54
7	7.41	24.56
8	-2.30	2.75
10	7.74	14.82
11	.13	10.25
12	5.59	-4.30
13	10.29	6.13
14	-5.45	-2.36
15	-22.92	-23.18
16	10.30	2.46
17	3.05	-24.45
18	-1.18	-5.00
20	-44.74	-47.61
21	-4.27	-4.00

Table 41

Summary Comparison of Bid Question Response by River: Logit and Open CVM

	Current Conditions Minus Large Trout Bid		Current Conditions Minus Doubled Trout	
[illegible]	Logit	Open CVM	Logit	Open CVM
[illegible]	11.20	-4.90	-22.80	-4.90
2	85.35	-9.43	-64.44	-10.36
3	132.84	-8.85	157.16	-8.30
[illegible]	-32.71	15.40	4.42	15.90
5	37.45	-32.62	130.42	-41.03
6	-30.06	19.95	30.23	22.54
[illegible]	-14.18	-2.30	.84	2.75
[illegible]	52.33	7.74	101.02	14.82
[illegible]	-104.86	5.59	-71.21	-4.30
[illegible]	96.62	10.29	5.92	6.13
[illegible]	21.93	-5.45	-34.04	-2.36
[illegible]	57.28	-22.92	31.41	-23.18
16	-43.58	10.30	-.65	2.46
[illegible]	4.14	3.05	10.07	-24.45
[illegible]	23.69	-1.18	5.17	-5.00
[illegible]	93.87	-44.74	4.78	-47.61
[illegible]	32.64	-4.27	33.72	-4.00
[illegible]	12	7	12	6
[illegible]	5	10	5	11

Table 42

Comparison of Bid Question

Responses by River: Logit and Open CVM

	Logit Method	Open CVM Method
a) Positive for Large Trout Question Only:		
	Beaverhead	Gallatin
	Big Hole	Smith
	Madison	
b) Positive for Doubled Trout Catch Only:		
	Blackfoot	Clark Fork
	Bighorn	
	Clark Fork	
c) Positive for Both Large Trout and Doubled Catch:		
	Bitterroot	Blackfoot
	Boulder	Big Horn
	Flathead	Flathead
	Kootenai	Kootenai
	Missouri	Rock Creek
	Smith	
	Stillwater	
	Upper Yellowstone	
	Middle Yellowstone	
d) Negative for Both Large Trout and Doubled Catch:		
	Gallatin	Beaverhead
	Rock Creek	Big Hole
		Bitterroot
		Boulder
		Madison
		Missouri
		Stillwater
		Upper Yellowstone
		Middle Yellowstone

Table 43

Montana Trout Stream Fishing

Means and Standard Deviation for Alternative TCM and CVM Measures of Net Economic Value Per Trip (By River)

Variable	Cases	Mean	Standard Deviation
1. Current Conditions:			
LOGITMN1	17	126.6941	57.3389
OPENALM1	17	28.0418	15.0118
OPENZRM1	17	50.7224	28.0042
LOGITMD1	17	48.5512	40.1432
OPENALD1	17	4.4706	3.2810
OPENZRD1	17	17.0588	10.3167
TCMPS	17	83.7088	51.0493
TCMPR	17	179.3753	109.3895
TCMGS	17	56.7882	28.0375
TCMGR	17	121.6876	60.0790
RIVER	17	10.8824	6.5468
2. Large Trout:			
LOGITMN2	17	131.4824	69.2199
OPENALM2	17	27.8065	12.4035
OPENZRM2	17	46.9376	20.2766
LOGITMD2	17	87.7688	68.7983
OPENALD2	17	6.4706	4.0638
OPENZRD2	17	20.1471	10.6972
3. Doubled Catch:			
LOGITMN3	17	125.4853	53.8014
OPENALM3	17	25.1971	12.1242
OPENZRM3	17	44.1994	21.2345
LOGITMD3	17	80.7376	68.9741
OPENALD3	17	5.0588	2.8167
OPENZRD3	17	17.4412	10.5281

(continued)

Table 43 (continued)

Variable Definitions

Logitmn1	"Logit means dolamt"
Logitmn2	"Logit means doldble1"
Logitmn3	"Logit means doldble2"
Logitmd1	"Logit medians dolamt"
Logitmd2	"Logit medians doldble1"
Logitmd3	"Logit medians doldble2"
Openalm1	"Open all means doltogo"
Openalm2	"Open all means dblecot"
Openalm3	"Open all means doldblct"
Openald1	"Open all medians doltogo"
Openald2	"Open all medians dblecot"
Openald3	"Open all medians doldblct"
Openzrm1	"Open zero means doltogo"
Openzrm2	"Open zero means dblecot"
Openzrm3	"Open zero means doldblct"
Openzrd1	"Open zero medians doltogo"
Openzrd2	"Open zero medians dblecot"
Openzrd3	"Open zero medians doldblct"
Tcmps	"TCM predicted standard"
Tcmpr	"TCM predicted reported"
Tcmgs	"TCM gum-martin standard"
Tcmgr	"TCM gum-martin reported"

Note: For CVM variables names last digit means: 1) bid question for current conditions; 2) bid for doubled catch of large trout; and 3) doubled trout catch. Openal are open CVM complete sample. Openzr are open CVM sample excluding zero bids.

Table 44

Listing of Net Economic Value per Trip for Ten Methodologies and Measures (by River)

River Code Number	River	LOGITMN1	LOGITMD1	OPENALM1	OPENALD1	OPENZRM1	OPENZRD1	TCMPS	TCMPR	TCMGS	TCMGR
1	Beaverhead	188.20	75.52	29.48	5.0	53.59	20	114.40	245.13	52.13	111.70
2	Big Hole	217.77	103.25	26.20	10.0	47.35	20	100.06	214.41	76.39	163.70
3	Bitterroot	58.83	9.19	28.90	.0	52.93	10	26.63	57.07	33.88	72.60
4	Blackfoot	132.86	28.22	11.06	2.0	21.49	10	80.31	172.09	66.18	141.81
5	Boulder	148.75	45.30	44.08	5.0	82.78	20	133.66	286.41	83.93	179.84
6	Bighorn	158.50	62.97	38.44	10.0	56.33	20	150.88	323.32	56.45	120.95
8	Clark Fork	86.49	10.60	13.68	2.0	24.69	10	37.12	79.54	31.71	67.96
10	Flathead	99.13	38.91	29.91	.0	43.91	10	8.10	17.35	26.35	56.46
12	Gallatin	179.98	46.95	15.51	5.0	28.59	10	92.26	197.71	75.32	161.41
13	Kootenai	38.13	7.01	11.10	2.0	20.24	10	65.83	141.07	26.29	56.33
14	Madison	228.12	168.34	52.24	5.0	103.34	50	138.77	297.35	109.32	234.26
15	Missouri	62.53	35.54	36.96	5.0	59.87	10	96.37	206.51	27.96	59.92
16	Rock Creek	92.17	32.62	13.24	5.0	25.60	15	164.97	353.51	80.58	172.66
17	Smith	152.87	65.32	35.47	10.0	64.00	30	56.95	122.03	43.77	93.80
18	Stillwater	84.87	28.30	16.32	.0	36.27	10	127.30	272.30	38.29	82.05
20	Upper Yellowstone	150.25	52.57	60.00	5.0	114.26	20	14.56	31.20	107.50	230.35
21	Middle Yellowstone	74.35	14.76	14.12	5.0	27.04	15	14.88	31.90	29.35	62.89

Note: For variable definitions, see Table 43.

Table 45

Comparative Analysis Across Angler Studies

Correlation Coefficient: Pearsons and Spearmans [1]

n = 17

Pearsons:

	LOGITMN1	LOGITMD1	TCMPS [2]	TCMGS [3]
LOGITMN1			.3818	.7253
LOGITMD1	.8592		.4246	.6454
OPENALM1	.4618	.5785	.0430	.5320
OPENALD1	.5978	.5102	.3481	.3594
OPENZRM1	.4859	.6053	.0564	.6139
OPENZRD1	.6811	.8824	.3180	.5936

Spearmans:

	LOGITMN1	LOGITMD1	TCMPS	TCMGS
LOGITMN1			.3750	.7132
LOGITMD1	.9191		.3848	.6176
OPENALM1	.4314	.6520	.1005	.3750
OPENALD1	.6249	.7097	.3862	.4671
OPENZRM1	.4706	.6912	.1422	.4657
OPENZRD1	.7076	.7903	.3558	.6341

---

[1] For variable definition, see Table 43.

[2] Identical correlation for TCMPR.

[3] Identical correlation for TCMGR.

Table 46

Sample Size and Comparison of TCM and CVM

Net Economic Value per Trip

River Code Number	River	TCM Sample Size			Value Per Trip			CVM Sample Size
		Zones	Trips	Trips/Zone	TCM[1]	CVM[2]	Ratio[3]	
1	Beaverhead	19	120	613	112	188	.59	108
2	Big Hole	37	187	5.1	164	218	.75	140
3	Bitterroot	12	88	7.3	73	59	1.24	117
4	Blackfoot	26	149	5.7	142	133	1.07	97
5	Boulder	16	57	3.6	180	149	1.21	69
6	Bighorn	28	160	5.7	121	159	.6	151
8	Clark Fork	17	231	13.6	68	86	.79	126
10	Flathead	12	66	5.5	56	99	.57	65
12	Gallatin	31	264	8.5	161	180	.89	152
13	Kootnai	11	121	11.0	56	38	1.47	72
14	Madison	55	396	7.2	234	228	1.03	155
15	Missouri	26	357	13.77	60	63	.95	148
16	Rock Creek	21	89	4.2	173	92	1.88	78
17	Smith	14	43	3.1	94	153	.61	44
18	Stillwater	15	133	8.9	82	85	.96	113
20	Upper Yellow.	32	81	2.5	230	150	1.53	121
21	Middle Yellow.	17	174	10.2	63	74	.85	105

Notes:

[1] Based on actual trips (Gum and Martin Method) and reported trave costs.

[2] Logit means with integration truncated at $500 bid value.

[3] TCM/CVM

Table 47

Summary Correlation Coefficients

For CVM and TCM by CVM Subsample

LOGITMN1 With TCMPR	LOGITMN1 With TCMGR	LOGITMN1 With OPENZRM1	OPENZRM1 With TCMGR
I. Complete Sample (n=17):			
		Pearson Correlation Coefficients	
0.5149	0.7253	0.4859	0.6139
p=.043	p=.000	p=.024	p=.004
		Spearman Correlation Coefficients	
0.5105	0.7132	0.4706	0.4657
sig.045	sig.001	sig.028	sig.030
II. Subsample Excluding CVM Sites With Less Than 80 Observations (n=12):			
		Pearson Correlation Coefficients	
0.3818	0.7993	0.3784	0.6814
p=.065	p=.001	p=.113	p=.007
		Spearman Correlation Coefficients	
0.3750	0.8112	0.2448	0.3287
sig.069	sig.001	sig.222	sig.148

Note: For variable definition see Table 43.

Table 48

Montana Trout Stream Fishing

CVM and TCM Bivariate Regressions

N	Dependent	Constant	Independent Variable				$\bar{R}^2$	F
			TCMPS	TCMPR	TCMGS	TCMGR		
17	LOGITMN1	90.797	.429				.088	2.56
	(T-STAT)	(3.48)	(1.60)				(SIG	.13)
17	LOGITMN1	90.797		.200			.088	2.56
		(3.48)		(1.60)			(SIG	.13)
17	LOGITMN1	42.466			1.483		.494	16.65
		(1.855)			(4.08)		(SIG	.00)
17	LOGITMN1	42.466				.692	.494	16.65
		(1.855)				(4.08)	(SIG	.00)
17	OPENZRM1	48.131	.031				-.063	.05
	(T-STAT)	(3.499)	(.219)				(SIG	.83)
17	OPENZRM1	48.131		.014			-.063	.05
		(3.499)		(.219)			(SIG	.83)
17	OPENZRM1	15.90			.613		.335	9.07
		(1.240)			(3.01)		(SIG	.01)
17	OPENZRM1	15.90				.286	.335	9.07
		(1.240)				(3.01)	(SIG	.01)
12*	LOGITMN1	81.675	.647				.192	3.61
	(T-STAT)	(2.527)	(1.900)				(SIG	.09)
12*	LOGITMN1	81.675		.302			.192	3.61
		(2.527)		(1.900)			(SIG	.09)
12*	LOGITMN1	36.485			1.682		.603	17.69
		(1.405)			(4.21)		(SIG	.00)
12*	LOGITMN1	36.485				.785	.603	17.69
		(1.405)				(4.21)	(SIG	.00)

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* Excludes sites where CVM sample is less than 80.

Final Report

INSTREAM FLOWS IN THE MISSOURI RIVER BASIN:
A RECREATION SURVEY AND ECONOMIC STUDY

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July 1990

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EXECUTIVE SUMMARY

SCOPE AND GENERAL APPROACH

This report provides the results of a recreation survey and economic study of instream flows in the Upper Missouri River Basin. The study was undertaken in cooperation with the Montana Department of Natural Resources and Conservation (DNRC). The authors and DNRC jointly developed the survey instrument. DNRC implemented the survey and developed the data base, while the authors are primarily responsible for the analysis.

This project was designed to provide detailed information on recreation and economics for the on-going water reservation process in the Missouri River Basin above Fort Peck Dam. The reservation process is complex and there are a large number of applicants for reservations. Montana Department of Fish, Wildlife and Parks (DFWP) has submitted an application for reservations on 240 specific streams or stream reaches in the basin. As recognized by DNRC, it was not feasible given the time and budget available for this project to collect information on all of the specific streams or reaches. In our view, the key to this project has been to design a survey that efficiently complements existing data sources and on-going related studies.

The basic scope of this study is to identify recreational use patterns, trip expenditures, current trip values, and a measure of how use and valuation vary with instream flows. Additionally, valuation is required to include nonparticipants in recreation. Because the scope and budget ruled out on-site surveys, we undertook a stratified random mail survey design. The strata included Missouri River Basin communities and out-of-basin Montana residents. This sample was drawn from Montana drivers licenses to avoid the gender bias in phone-based sampling. Additionally, we sampled the major nonresident use group for the Missouri River basin, nonresident anglers, through DFWP license records.

It would require a very large household survey sample to permit disaggregating user-related valuation estimates to the stream reach level. For example, 9000 surveys were mailed for this study and of these only 2058 respondents had taken trips to the basin. Accordingly, the survey was designed to provide key information that can be tied to existing models and data bases. For example, with regard to total use (number of visits), the only existing statewide site-specific data base on recreational use is Montana Department of Fish, Wildlife and Parks (DFWP) angler pressure surveys. This survey has fishing use estimates on a stream specific basis. By using the mail survey to estimate activity proportions (including the proportion of users that are anglers), the mail survey was tied to DFWP's site specific estimates for anglers to derive total use. Similarly, changes in both use and valuation in response to decreased instream flows were identified in terms proportional to current trip values. Following Narayanan (1986), these generic response functions were applied where appropriate to basin and water specific current trip values developed through the mail survey.

To summarize the overall approach, we undertook a large mail survey that was designed to complement existing work. The remainder of this executive summary provides a brief discussion of theory and methods, data, descriptive statistics, and valuation of recreation and flows. Survey instruments and supporting technical information are provided in the appendices and the chapters that follow this summary.

THEORY AND METHODS

The basic approach taken to valuing recreational trips was the contingent valuation method. This approach amounts to directly surveying individuals as to their willingness to pay for a given activity or commodity. Contingent valuation is one of two general methods that have been approved for valuing recreational activity by the U.S. Water Resources Council. The question format utilized was dichotomous choice; in this approach a respondent is faced with a given dollar amount and provides a simple yes or no answer. A sample of these responses is used to derive the relationship between the probability of a yes response and the dollar bid amount. From this relationship (usually modeled as a logistic function), a measure of mean willingness to pay for the population is derived. Recently developed methods for optimally designing the set of offer bids were employed (Appendix C). A limitation of previous dichotomous choice contingent valuation studies is the absence of a measure of precision for the willingness to pay values. In this study a statistical technique, bootstrapping, was employed to estimate standard errors and associated confidence intervals.

Two different valuation questions were asked in this study. One series of questions asked the respondent to identify a Missouri River Basin water (river or reservoir) recently visited. The respondent was then asked his/her total trip expenses and a followup question of the form: "Suppose your trip expenses increased by (dollar amount) would you still have chosen to take the trip?." The dollar amount was randomly varied across respondents. The response is used to identify the value of a given recreational trip (or experience) and has been widely applied.

The second type of question was designed to measure preservation values. Three types of preservation values, existence value, option value and bequest value, have been examined in the economics literature. Existence value is the value one places on knowing a resource exists even if he/she has no plans to ever visit or use the resource. Option value is that value one places on preserving the option of using a resource in the future. Finally, bequest value is that value placed on knowing a resource will be available for future generations to use. Previous studies have shown that some resources may have considerable value not associated with direct use. For example, people who have no expectation of ever seeing the Grand Canyon may place a high value on knowing it is protected for future generations. We asked the respondents' willingness to pay to contribute to a trust fund to improve instream flows in Missouri River Basin streams. This format has been widely used to measure the value for given recreational or wildlife resources held by nonparticipants.

The relationship between instream flows and recreational use was determined through a contingent behavior question first used by Narayanan (1986). Respondents were asked (for a recent recreational trip they took to a Missouri River Basin stream) at what level of flow they would discontinue use. Alternative flow levels were presented as varying percentages of the flow they experienced (such as 50 percent or 75 percent of current flow). These responses were used to estimate the cumulative proportion of current use that would be observed at alternative flow levels for a given water.

DATA

A stratified mail sample was used. A total of 9000 questionnaires were mailed; 2000 to residents of each of three subbasins of the Missouri River system (upper, middle and lower), 2000 to out of basin Montana residents and 1000 to holders of nonresident conservation licenses. Dillman's Total Design Method was used with a postcard reminder and a second mailing to nonrespondents. A total of 7061 surveys were delivered and 3845 of these responded for an overall response rate of 54 percent. A phone survey of 150 nonrespondents was also conducted. The previously mentioned DFWP angler use survey included a mailing of 36,000 surveys in 1985. A total of 19,271 surveys were returned. An examination of DFWP angler license sales indicated only a 1.3 percent increase between 1985 and 1989. This suggests that 1989 angler use may be slightly under-estimated based on the use of 1985 data.

RECREATIONAL USE AND EXPENDITURE

In addition to the valuation questions mentioned previously, the survey included questions related to user characteristics, attitudes, use and expenditures. Responses to several questions indicated that water for recreational use is very important to

Montanans.

Recreational use in the Missouri River Basin of Montana totaled over 2 million recreation days in 1989. Approximately 86 percent was resident use and 14 percent nonresident. The use was divided with 61 percent occurring on rivers and streams and 39 percent on reservoirs. The dominant activity is fishing, accounting for about 60 percent of total use. Use estimates and confidence intervals are provided separately in the report at the subbasin level and for major drainages and reservoirs. The aggregate estimates are relatively precise; for example the 95 percent confidence interval for resident use of rivers and streams is only plus or minus 11 percent of the mean estimate. (This confidence interval includes both the statistical precision of the DFWP angler use estimates as well as the statistical precision of parameters used from the current study such as estimated proportion of total use that is due to anglers.)

Average expenditures per trip for residents recreating in the basin were $113, compared to $640 for nonresidents. There was considerable difference for nonresident expenditures by water type, with an average of $797 per trip for visits to rivers versus $366 for visits to reservoirs. Total trip-related expenditures in the basin were $70 million for residents and $45 million for nonresidents. This indicates a significant state level economic benefit from ~~to~~ water-based recreation in the basin. It is interesting to note that nonresident expenditures were concentrated in the Upper Basin (above Three Forks) with 85 percent of all out-of-state expenditures being in this area. Similarly, nonresident expenditure was concentrated on streams and rivers (87 percent) as opposed to reservoirs. This indicates that from the standpoint of state economic impact, far and away the most important resource in the basin is the streams in the Upper Basin region including the Madison, Gallatin, Jefferson, Beaverhead and Big Hole. These waters are destination fisheries.

CURRENT TRIP VALUES

From the standpoint of recreationists (and society as a whole) expenditures are a cost, not a benefit. The net benefits of recreation are measured as net willingness to pay over and above costs. These benefits are in part captured by the river owner in a fee fishery setting such as is common in the British Isles or Norway. In this country, these benefits usually are retained by the recreationist who enjoys open public access to recreational resources.

The dichotomous choice contingent valuation models provided current trip estimates of $134 to $175 per trip for residents and from $507 to $793 per trip for nonresidents. On a per day basis the resident values are $40 to $66 across subbasins and water types. These values are similar to estimates reported in a recent review of 120 outdoor recreation studies by Walsh, Johnson and McKean (1988). The estimates are also consistent with previous Montana specific studies. It may be noted that prices observed in Montana fee fisheries are in the same range. Currently the daily fee at Nelson Spring Creek is $40 and the fee on Red Rock River is $45. The average values per day for nonresidents are $193 for rivers and $128 for reservoirs. These values reflect the higher income levels of nonresidents and the high quality of the Upper Basin fisheries compared to other sites in the U.S.

The total net economic value of water-based recreational use in the Missouri River Basin of Montana is $144 million. This estimate is derived from estimated total use and estimated value per day. Assuming a four percent real discount rate into perpetuity, the net present asset value of these recreational resources is $3.6 billion.

INSTREAM FLOW VALUES

Survey respondents were asked how the 1988 drought-induced low flows affected their recreation. A substantial share of respondents (52 percent of residents and 34 percent of nonresidents) indicated that they took fewer trips because of the low flows in 1988. Less than two percent of all respondents indicated that they took more trips due to low flows. A substantial share of respondents also indicated that the quality of their recreational experience was lower because of inadequate stream flow experienced in 1988. These results indicate that potentially significant economic impacts may be associated with low stream flows.

Logistic models were estimated that related total recreational use to alternative flow levels at the subbasin and water type level. Models were estimated separately for July-August and rest of year to match relatively homogenous use and flow level periods. These models fit the observed data very well, generally explaining over 90 percent of the variation in the various subsamples. The estimated models generally indicate that use is most sensitive to changes in flow at a level around 65 to 70 percent of the flows experienced in 1989. Use is least sensitive to flow levels for small changes from the levels experienced and also at very low flows. These results have a practical appeal in that they suggest a threshold range where some activities such as boating become impossible, at some flow level.

The estimated values per acre-foot of changing flow levels varied considerably across sites and time periods. For example, July-August flow changes at around 75 percent of 1989 experienced flows in the Upper Basin rivers were valued at $68 per acre foot while changes in Lower Basin (below Fort Benton) river flows were valued at $11. In general, the summer season values were much higher than the rest of year averages. At 75 percent flow levels, changes in Upper Basin river levels for June-September were valued at $23 and Lower Basin river level changes were valued at $4. These value differences reflect when and where people tend to recreate in the Missouri River Basin. In general, the marginal values of instream flows in Missouri River Basin streams appear to be comparable to or in excess of the value of typical competing water uses.

Values were also estimated for changes in the water content of major basin reservoirs. The July-August estimates varied from $1.41 per acre foot-month in the Middle Basin to $.06 in the Lower Basin. Values for the rest of year were from $1.14 in the Upper Basin to $.02 in the lower. The Lower Basin values are less because fewer people recreate in the lower basin relative to the size of the Lower Basin reservoirs. Standard errors for all estimates are reported in the paper.

The estimated values per acre foot for instream flows were compared to other Montana specific instream flow valuation studies. Despite considerable differences in methodology and data, the estimates from the current study were similar to the results of previous research in this area.

INSTREAM FLOW TRUST FUND RESPONSE

The benefits of instream flow extend beyond the provision of habitat for fish, wildlife and recreation. Keeping adequate amounts of water in rivers and streams also has intrinsic or indirect values to many people. Individuals may value simply knowing that there are large and free-flowing rivers flowing through natural areas, even if they never see it for themselves. They also may benefit from knowing that a given river is protected for future generations.

Survey respondents were asked if they would donate to a hypothetical trust fund to maintain summertime flows in Missouri Basin streams. Following the usual approach taken in the economics literature,the responses to the dichotomous choice contingent valuation question were used to estimate a logistic relationship. The estimated model fit the data well and estimated parameters were consistent with economic theory. For example, individuals with higher income levels were more likely to donate. The estimated mean donation varied from $14 for out of basin Montana residents to $33 for nonresident anglers. The total trust fund value was estimated to be $13.6 million annually. These results indicate that there may be substantial indirect or preservation values associated with Missouri Basin streams.

The estimated trust fund value was similar to other studies of indirect values associated with river preservation. For example, the value of protecting water quality in Flathead River and Lake estimated a trust fund value of $18 million for Montana residents. This study also estimated a regional value (including adjacent states and provinces) for protecting the Flathead of $111 million. Our estimate for a Missouri Basin trust fund is probably very conservative since only nonresident anglers were sampled. It is likely that other nonresidents besides anglers may place a preservation value on Montana's rivers.

CONCLUSION

This study shows very significant recreation and preservation values associated with Missouri River Basin waters. These values vary considerably from one site to another and are highest in the Upper Basin.

Table of Contents

Page

ACKNOWLEDGEMENTS i

EXECUTIVE SUMMARY ii

TABLE OF CONTENTS viii

LIST OF TABLES xi

LIST OF FIGURES xiv

CHAPTER I: Introduction 1
- Scope of Study 1

CHAPTER II: Theory and Methods 3
- Literature Review of Contingent Valuation Method .. 3
- Dichotomous Choice CVM 6
- Standard Errors 9
- Instream Flow Valuation 10
- Existence Value of Instream Flow 13

CHAPTER III: Data Sources 15
- Nonresponse Analysis 17

CHAPTER IV: Descriptive Statistics and Use Levels 19
- Characteristics of Recreationists 20
- Characteristics of Recreational Trips 21
- Recreational Use Statistics 22
- Expenditure Statistics 41

CHAPTER V: Current Trip Valuation Analysis 57
- Valuation of Current Recreational Trips.......... 57
- Outlier and Protest Responses 58
- Current Trip Sample Aggregation 59
- Functional Form 60
- Benefit Estimation 61
- Calculation of Total Net Economic Values 62
- Comparison to Previous Studies 69

CHAPTER VI: Valuation of Instream Flows 70
- The Flow / Visitation Model 71
- Estimated Equations 73
- Calculation of Marginal Flow Values 76

Calculation of Average Flow Values 81
Limitations of the Flow Analysis 81
Comparison to Previous Flow Valuation Studies 84

CHAPTER VII: Instream Flow Trust Fund Valuation 88
Trust Fund Format 88
Functional Form 89
Estimated Equations 89
Trust Fund Benefit Estimates 92
Comparison to Previous Estimates 95

CHAPTER VIII: Conclusions 98

REFERENCES 100

APPENDIX A: Survey Instruments 105

APPENDIX B: Computational Notes 114

APPENDIX C: Bid distribution Analysis: DNRC Missouri River Basin Recreation Study 120

APPENDIX D: Detailed Flow / Valuation Tables 134

List of Tables

Table	Title	Page
1	Comparison of Respondent and Nonrespondent Means	18
2	Percentages of Respondents Either Strongly Agreeing or Agreeing with Statements on Water Use	19
3	Demographic Variables for Residents and Nonresidents ...	20
4	Trip Characteristics for Resident and Nonresidents who had Taken a Recent Trip	21
5	Major Rivers and Streams Included in DFWP Drainage Classifications	23
6	Angler Use Days 1985, River and Stream Subsample	25
7	Angler Use Days 1985, Reservoirs	26
8	Angler Use Days 1985, Selected Major Reservoirs	27
9	Total Angler Use Days 1985, By Subbasin	28
10	Angler Proportion of Total Use 1989	29
11	Angler Proportion of Total Use 1989, By Drainage, River and Stream Subsample	30
12	Angler Proportion 1989, Selected Major Reservoirs	31
13	Angler Proportion 1989, By Activity and Subbasin	32
14	Angler Proportion 1989, Missouri Basin Average, by Activity	33
15	Estimated Total Recreational Use Days 1989, By Subbasin.	34
16	Estimated Total Recreational Use Days 1989, By drainage River and Stream Subsample	35
17	Estimated Total Recreational Use Days 1989, Selected Major Reservoirs	36
18	Angler Use Days, 95% Confidence Intervals derived from Table 6, River and Stream Subsample	37
19	Angler Use Days, 95% Confidence Intervals derived from Table 7, Reservoir Subsample	38

20 Total Recreational Use Days 1989, 95% Confidence Intervals Derived from Table 14, River and Stream Subsample 39

21 Total Recreational Use Days 1989, 95% Confidence Intervals Derived from Table 14, Reservoirs 41

22 Comparison of Expenditure Estimates Across Studies Aggregated Sample; All Waters / All Anglers 44

23 Comparison of Per Day Angler Expenditure Estimates River and Stream Subsample 44

24 Per Trip Expenditures 1989, By Subbasin 45

25 Average Number of Days Per Trip 1989, By Subbasin 46

26 Average Expenditures Per Day 1989, By Subbasin 47

27 Average Expenditures Per Trip 1989, By Activity Type ... 49

28 Expenditure Per Day by Activity Type 1989,Resident Subsample 50

29 Total Recreational Expenditures, River and Stream Subsample, By Subbasin 51

30 Total Recreational Expenditures, Reservoir Subsample By Subbasin 52

31 Total Recreational Expenditures, All Waters Combined By Subbasin 53

32 Total Recreational Expenditures, 95% Confidence Intervals Derived form Table 29, Rivers and Streams 54

33 Total Recreational Expenditures, 95% Confidence Intervals Derived from Table 30, Reservoirs 55

34 Total Recreational Expenditures, 95% Confidence Intervals Derived from Table 31, All Waters 56

35 Estimated Bivariate Equations, Current Trip Regression . 63

36 Estimated Multivariate Equations, Current Trip 64

37 Average Net Economic Values Per Trip, Calculated From Bivariate Logit Models in Table 32 65

38 Average Net Economic Values Per Day, Current Trip 66

39 Total Net Economic Value, Current Trip Question 67

40 Total Net Economic Value, 95% Confidence Intervals based on Table 39 68

41 Estimated Flow / Visitation Equations 75

42 Marginal Values Per Acre Foot of Flow, Rivers and Streams, Resident Use 79

43 Marginal Values Per Acre Foot of Flow, Rivers and Streams, Nonresident Subsample 79

44 Marginal Values Per Acre Foot of Flow, Rivers and Streams, Total for Resident and Nonresident Use 80

45 Per Month Marginal Values Per Acre Foot of Flow, Reservoirs, Resident Subsample 80

46 Average Values Per Acre Foot of Flow 83

47 Estimated Logistic Regression Models, Trust Fund Question 90

48 Estimated Bivariate Equations, Trust Fund Question 91

49 Truncated Mean and Median Values, Trust Fund Question .. 93

50 Total Value of Missouri River Basin Trust Fund 93

51 Confidence Intervals on Trust Fund Valuation Figures ... 94

52 Studies of Preservation Value of Rivers 97

53 Estimated Preservation Values for Rivers 97

List of Figures

Figure	Title	Page
1	Map of Missouri River Subbasin Boundaries	16
2	Visitation vs. Instream Flows, Lower Subbasin Rivers	72
3	Predicted vs. Actual Responses, Resident Use on Upper Subbasin Rivers in July and August	74
4	Marginal Instream Flow Valuation	78

Chapter I

INTRODUCTION

Scope of Study

This report provides the results of a recreation survey and economic study of instream flows in the Upper Missouri River Basin. The study was undertaken in cooperation with the Montana Department of Natural Resources and Conservation (DNRC). The authors and DNRC jointly developed the survey instrument. DNRC implemented the survey and developed the data base, while the authors are primarily responsible for the analysis.

This project was designed to provide detailed information on recreation and economics for the on-going instream flow reservation process in the Missouri River Basin. The reservation process is complex and the scope is very broad. For example, Montana Department of Fish, Wildlife and Parks (DFWP) has submitted reservations on 240 specific streams or stream reaches in the basin. As recognized by DNRC, it was not feasible given the time and budget available for this project to collect information on all of the specific streams or reaches. In our view, the key to this project has been to design a survey that efficiently complements existing data sources and on-going related studies.

The basic scope of this study is to identify use patterns, trip expenditures, current trip values, and measure how use and valuation vary with flow. Additionally valuation is required to include nonparticipants in water-based recreation. Because the scope and budget ruled out on-site surveys, we undertook a stratified random mail survey design. The strata included Missouri River Basin communities and out-of-basin Montana residents. This sample was drawn from Montana drivers licenses to avoid the gender bias in phone-based sampling. Additionally, we sampled the major nonresident use group for the Missouri River basin, nonresident anglers, through DFWP license records. For example, use on the Big Hole in 1988 was over 90 percent fishing and approximately half of these users were nonresidents. As detailed below, the mail survey was designed to address all elements of the scope including current trip valuation and indirect values. The nonmarket valuation method chosen was dichotomous choice contingent valuation.

Even a fairly large household survey sample will not permit disaggregating user-related valuation estimates to the stream reach level. Accordingly, the survey was designed to provide key information that can be tied to existing models and data bases.

For example, with regard to total use (number of visits), the only existing statewide site-specific data base on recreational use is Montana Department of Fish, Wildlife and Parks (DFWP) angler pressure surveys. This survey has fishing use estimates on a stream specific basis. By using the mail survey to estimate activity proportions (including the proportion of users that are anglers), the mail survey was tied to DFWP's site specific estimates for anglers to derive total use. Similarly, changes in both use and valuation in response to decreased instream flows were identified in proportional terms to current trip values. Following Narayanan (1986), these generic response functions were applied where appropriate to basin and water specific current trip values developed through the mail survey. The study was also designed to complement and utilize where possible previous research in Montana on trip values (eg. Duffield, Brooks and Loomis, 1987; Duffield and Allen, 1988) and instream flows (Neher, 1989; Duffield, Butkay, and Allen, 1990).

To summarize the overall approach, we undertook a large mail survey that was designed to complement existing work. The remainder of this report provides a detailed discussion of theory and methods, data, descriptive statistics, and valuation of recreation and flows. Survey instruments and supporting technical information are provided in the appendices.

Chapter II

THEORY AND METHODS

This chapter begins with a literature review of contingent valuation methods (CVM) and follows with a description of the specific valuation technique employed in this study: dichotomous choice contingent valuation. The remainder of this section describes the extension of this basic method to address the major study objectives.

Literature Review of Contingent Valuation Methods

The two most widely used methods for estimating net willingness to pay for outdoor recreation are CVM and the travel cost model (TCM). These are also the two general methods recommended by the U.S. Water Resources Council for valuing recreation in federal cost benefit analysis. The travel cost approach estimates demand functions for a given site from observed visit rates corresponding to the supply prices (travel costs) from origins surrounding the site. A regional TCM application to Montana fisheries is described in Duffield, Loomis and Brooks (1987). A regional TCM model is not appropriate for this study because of budget limitations and its inability to measure indirect values.

In the CVM approach individuals are directly surveyed on their willingness to pay for the services of a given resource contingent on the existence of a hypothetical market situation. This is a very flexible technique and has been applied to a wide range of environmental and resource issues including air and water quality changes, scenic beauty, and wildlife (Cummings, Brookshire and Schulze, 1986), and instream flows (Loomis, 1987). The only limitation of the method is the ability of the researcher to frame understandable questions and the willingness and ability of the respondent to accurately value the good or service.

Bishop and Heberlein (1985) have described six key methodological choices in a CVM application: 1) target population, 2) product definition, 3) payment vehicle, 4) question format, 5) method of analysis, and 6) supplemental data. With respect to population, the choice generally hinges on what types of values are being addressed. TCM studies, by necessity, and most CVM studies focus on the values associated with direct use; accordingly, the target population is direct users (such as boaters and anglers). However, there is a considerable literature on indirect or nonuser values such as option, existence and bequest values (Fisher and Raucher, 1984). Estimating the latter typically implies a regional population addressed through a household survey.

Product definition and payment vehicle are two key features of the hypothetical market. The resource or service at issue must be clearly described to the individual. This may be difficult for valuing changed conditions, such as the specific physical characteristics of a proposed hydropower installation (Duffield, 1984). Visual aids such as photos and charts have been used (Daubert, Young, and Gray, 1979; Desvousges, Smith and McGivney, 1983). A problem is that the specific information given the individual can bias the response. A general approach is to vary the level of information and test for benefit sensitivity.

Just as for the product definition, it is generally agreed that a payment vehicle must be specified for the respondent. Mitchell and Carson (1981) suggest two criteria for an appropriate vehicle: realism and neutrality. Taxes or site fees may be means of payment that could be realistically employed for public resource use. However, responses to such vehicles may be more influenced by dissatisfaction with high taxes or aversion to fee fishing (for example) than by the value placed on the resource.

A vehicle that has been used successfully for hunting studies is an increase in trip expenses. Hammack and Brown (1974) used this approach in an innovative study of waterfowl hunting. As Bishop and Heberlein (1985) note, this is an appealing vehicle for such studies since respondents are familiar with paying expenses and expenses appear relatively neutral compared with other vehicles such as hunting fees. Past instream flow studies have used trip cost, entrance fee, and sales tax payment vehicles, while studies of water quality benefits have added willingness to drive and the cost of waterfront property (Walsh et al., 1978).

Based on previous studies (Duffield, Butkay and Allen, 1990) , this study utilizes a trust fund payment vehicle to identify total willingness to pay for the protection of instream flows and a trip expense vehicle for valuation of direct use alone.

The major methodological choice in a CVM study is the question format or value elicitation procedure. The latter also usually implies the type of analysis that will be undertaken. There are numerous variations, but four general approaches for asking CVM questions can be identified: open-ended questions, bidding games, dichotomous-choice questions, and contingent-ranking techniques. It is beyond the scope of this paper to review these methods in detail (for a recent review see Cummings, Brookshire and Schulze, 1986); however, the key features of each will be briefly described.

The open-ended is the simplest approach: respondents are asked their maximum willingness to pay for use of the given resource. This approach can be utilized in a mail survey and is therefore low cost. Interpretation is also fairly straightforward, requiring only the calculation of the mean offer amount. One difficulty can be in interpreting extreme values. For example, responses of "zero" may indicate a protest response against the payment vehicle or even against the idea that a given resource has a finite value. Generally, follow-up questions are included that attempt to identify the reasons for a zero response. Similarly, it is often not clear what credibility can be attached to extremely high values. In general, the limitation of this approach is that respondents may not have sufficient information or stimulation to fully consider the value they place on the resource.

The most widely used alternative to the open-ended format is a bidding game, where interviewers ask the respondent for a yes or no response to a specific bid amount. If the respondent is willing to pay, for example, $10, the bid is raised in increments until the maximum willingness to pay is determined. Stoll (1983) argues that such an iterative approach is necessary to force individuals to engage themselves in the hypothetical market and continuously reconsider their willingness to pay.

There is some disagreement in the literature on whether the two approaches in fact yield consistently different results. Cummings, Brookshire and Schulze (1986) conclude that open-ended results are generally lower. However, Bishop et al (1984) compared open-ended questions and bidding games and found no significant difference. There are two major limitations to the bidding game approach. It is costly in that it requires face to face or telephone interviews. Second, many studies have shown a positive correlation between the initial (and arbitrary) bid and the final maximum bid. Empirical evidence of this starting point bias has been presented by Duffield (1984) and many others.

The dichotomous choice approach combines some of the better features of both open-ended and bidding. In dichotomous choice, the individual is faced with a single specific dollar bid and (like bidding games) the response is a simple market-like yes or no. The dollar bid amount is systematically varied across respondents. Since the format is non-iterative (like the open-ended), it is amenable to mail survey and is therefore relatively low cost. This approach is relatively new, but has been successfully applied to valuation of hunting permits (Bishop and Heberlein, 1980), boating and scenic beauty (Boyle and Bishop, 1984), reservoir recreation (Sellar, Stoll and Chavas, 1985) and beach recreation (Bishop and Boyle, 1985).

The major disadvantage of dichotomous choice is that analysis is more complex. This method exploits some of the considerable advancement in methods for modeling discrete choice over the previous decade (Amemiya, 1981). Econometric models such as the logit model are used to predict the probability of accepting an offer as a function of the stated bid and other socio-economic variables, as detailed below. There is some debate over the appropriate welfare estimate for such studies (Hanneman, 1984 and 1989) and issues regarding truncation and functional form are still being resolved.

A related method is contingent-ranking. Here the respondent ranks alternative combinations of environmental resources and monetary outlay. This method also requires the application of econometric techniques (Desvousges, Smith and McGivney, 1983).

As for any model of economic demand, the CVM estimates are generally improved by including at least the conventional demand shifter variables such as income, price and availability of substitutes, and measures of tastes and preference. This is most critical for the dichotomous choice case, where incomplete specification could lead to omitted variable bias. For the open-ended and bidding game methods, analysis amounts to taking the mean of the maximum willingness to pay bids. However, for these two methods it is conventional practice to estimate "bid equations" that relate willingness to pay to demand shifter variables to help establish the credibility of responses.

As is obvious from this review of the CVM literature, there are advantages and disadvantages to each method. The dichotomous choice method was selected for this study. Major considerations were high interview cost and starting point bias associated with the bidding game format.

Dichotomous Choice CVM

In dichotomous choice, individuals respond "yes" or "no" as to their willingness to pay a specific cash amount for a specified commodity or service. If it is assumed that each individual has a true willingness-to-pay (WTP), then the individual will respond positively to a given bid only if his WTP is greater than the bid. As Hanneman notes, this can be made explicit in a simple indirect utility difference specification (Boyle and Bishop (1988) provide an application). Accordingly WTP has a straightforward welfare interpretation as an equivalent or compensating variation measure, depending on the question context.

The probability P that an individual will respond positively to a bid of amount x is then

$$1)\quad P = \Pr(WTP > x) = 1 - F(x)$$

where F is the cumulative distribution function (c.d.f.) of WTP values in the population.

The standard analysis of dichotomous choice data assumes in equation 1) that the distribution of WTP values is logistic, a two-parameter distribution similar in shape to the normal. This leads to the logit model

2) $L = \log(P/(1-P)) = a + bx$.

where L is the *logit* or the log of the odds of paying the bid amount x, and a and b are parameters to be estimated from the data. For the time being, we assume that there are no covariates, such as income, but we show shortly how those can be incorporated. Equation 2) can be rewritten explicitly in terms of P, the probability of paying the bid amount x:

3) $P = (1 + e^{-a - bx})^{-1}$.

Hanemann (1984) has shown that the logit model in 2) and 3) is consistent with the hypothesis of utility maximization. Unfortunately, it has generally been found not to fit contingent valuation data very well. The logistic distribution is symmetric and allows for negative values; observed WTP distributions appear to be skewed to the right and are, of course, always greater than zero. If the bid value x is replaced by *ln*(x), then the model is

4) $L = \log(P/(1-P)) = a + b \log(x)$.

This model implies that the distribution of the *ln*(WTP) values is logistic and so that the distribution of WTP values is log-logistic. This latter distribution is bounded below by zero and skewed to the right. Model 4) has generally been found to give a much better fit to dichotomous choice data. Hanemann (1984) has shown that this model is inconsistent with a standard utility maximization model, but Cameron (1988) has suggested that it simply be viewed, like any statistical model, as an approximation to an unknown, and perhaps very complex, utility maximization model.

Covariates can also be incorporated into the logit model by using the equation

5) $L = a + b'x$

where b is a vector of parameters and x is a vector of explanatory variables, including bid amount (or *ln*(bid)), measures of taste, income and other standard demand shifter variables. The equivalent equation for P is then

6) $P = (1 + e^{-a-b'x})^{-1}$.

This model implies that the conditional distribution of WTP values, or *ln*(WTP) values if *ln*(bid) is used, given the values of the covariates, is logistic with a constant variance and a mean which depends linearly on the covariates. Again, using *ln*(bid) instead of bid gives WTP distributions which are more consistent with what has been observed.

Model 4) and model 6) with *ln*(bid) are used in the analyses here for the reasons given above. In estimating welfare values, covariates are of interest only if they significantly improve the fit of the model to the data. Therefore, model 4), which provided a good fit in most cases, is used for this purpose.

The logit model can be fit by maximum likelihood to yield maximum likelihood estimates (MLE's) of a and b. Maximum likelihood fitting for the logit model requires iterative numerical methods. We used the logit routine in SAS (SAS, 1988) to fit the models used in this report. MLE's of functions of the parameters a and b can be obtained by simply substituting the MLE's of a and b into the function.

Once the estimated distribution of WTP values is obtained from model 4), we wish to calculate a measure of the welfare surplus for an "average" or "typical" individual. Three measures have been suggested in the literature (Hanemann 1984): the median, the mean, and the truncated mean. When the WTP distribution is skewed, these measures can differ considerably. The median is probably the best measure of a "typical" individual's WTP, but it cannot be aggregated over the population to give an estimated total value of the resource for the population. The mean is the measure of choice on purely theoretical grounds if one wishes to be able to aggregate the values. That is, the total value of the resource can be estimated by multiplying the estimated mean value per individual by the number of individuals in the population of interest. However, in the logit model 4), the WTP distribution is skewed to the right and the mean can be far out in the tail of the distribution (in fact, the mean can be infinite in some cases). This tail is unobserved beyond the maximum bid amount. The estimate of the mean is therefore heavily dependent on extrapolation of the fitted model into the tail of the WTP distribution and we have no way of knowing if the extrapolation is accurate. The truncated mean represents a compromise between the median and mean. It is computed by first determining a truncation point T, then replacing all estimated WTP values greater than T by T, and computing a mean in the usual way. Thus, the influence of the tail of the distribution is reduced. The truncated mean does not rely on extrapolation of the fitted model beyond T because the actual distribution of WTP values above T doesn't matter. In addition, the truncated mean can be aggregated over the population -- when the estimate is multiplied by the population size, it gives an estimate of the population total WTP after values above T have been replaced by T.

There are two ways to view the truncated mean as an estimator of welfare. One is that it is an underestimate of the true mean -- that it represents an estimated minimum value of the true mean -- but that the true mean cannot be reliably estimated because it is not valid to extrapolate beyond the range of the data. The second is that, on distributive grounds, it may be desirable to limit the contribution of any individual to total WTP. In this case, even if the tail of the WTP distribution were known, we would truncate at T. The determination of the truncation point T is a judgement, just as the choice of the median, mean or truncated mean is a judgement.

Many applications have used the truncated mean as the welfare measure (for example, Bishop and Heberlein 1980 and Sellar, Stoll and Chavas 1985). In this study, we report both the median and truncated mean WTP. The truncation value is equal to the maximum bid. The truncated mean is used in all aggregations. It should be realized that this represents a conservative estimate of the true mean (hypothetical) WTP because all individuals having WTP greater than T are included at the value T. Also, different truncation points were used for residents and nonresidents which means that the truncated means for these two groups are not directly comparable.

Formulas for the three welfare measures described above for the model in 4) are:

$$7)\ \text{Median} = \exp(-a/b)$$

$$8)\ \text{Mean} = E(\text{WTP}) = \int_0^\infty x f(x)\, dx = \int_0^\infty (1 - F(x))\, dx$$

$$9)\ \text{Truncated mean} = \int_0^T \min(x,T) f(x)\, dx = \int_0^T (1 - F(x))\, dx$$

where $f(x) = dF(x)/dx$ is the probability density function of the WTP distribution. Numerical integration is necessary to calculate the mean and truncated mean. MLE's of a and b were substituted into the above formulas to obtain sample estimates.

Two specific dichotomous choice valuation questions were utilized in this study: current trip valuation and trust fund contribution for protection of instream flows.(See Appendix A for specific wording of each question.) All of these valuation questions were estimated in the form of equation (4).

Standard Errors

Standard errors for truncated means, quantities like expenditures per day and other combinations of variables were estimated with a combination of methods. Exact formulas for standard errors are not available for the logit model and for ratios and products of correlated quantities, such as total expenditures on a trip and number of days in the trip. Bootstrapping (Efron 1982) was used where possible. Bootstrapping in the logit model is described in Duffield and Patterson (1990). Where bootstrapping was not possible, the delta method (Bishop, Fienberg and Holland 1975) was used to derive approximate asymptotic expressions. The primary two were:

$$10)\ \text{Var}(X/Y) = [1/(EX)^2]\,[(EX/EY)^2\,\text{Var}(X) + \text{Var}(Y) - 2(EX/EY)\text{Cov}(X,Y)]$$

11) $Var(XY) = (EX)^2\ Var(Y) + (EY)^2\ Var(X) + 2(EX)(EY)Cov(X,Y)$

If X and Y are independent, then an exact formula for Var(XY) is:

12) (X,Y indep.) $Var(XY) = Var(X)Var(Y) + (EX)^2\ Var(X) + (EY)^2\ Var(Y)$

INSTREAM FLOW VALUATION

To date there have only been a few economic studies of instream flows. It is useful to recognize that changing flows will affect both the quality of recreational use and the amount of use. Both of these influences may be represented by flow as a "shift" variable in a demand function specification. In general, existing studies have focused on either the quality or quantity change. For example, Daubert and Young (1981) and Bishop, Brown, Welsh and Boyle (1989) used the CVM technique and faced respondents (on site interviews) with alternative flow scenarios. The former study used photos of 8 flow conditions in the Poudre River in Colorado, and the latter developed descriptions of 6 flow scenarios for white water rafters in the Grand Canyon and for Glen Canyon anglers. This approach provides a measure of quality changes. Additionally, Bishop et al (1989) used a current trip valuation question and included actual flows as an independent variable in a logistic equation. This approach also does not correct for possible changes in amount of use (i.e. number of visitors). However, this may well be appropriate for the Grand Canyon where use is constrained by a permit quota and there is considerable excess demand. Both the Poudre and Colorado River studies derived relationships between average consumer surplus and flow levels.

An alternative model has been developed by Narayanan (1986) in a study of the Blacksmith Fork River in Northern Utah. Narayanan combined a travel cost model estimate of current valuation with a direct survey based logistic model of participation as a function of flows. Specifically, recreationists were asked on site how much flows would have to decline (as a percent of current flows for 8 specific percentiles) before the individual would discontinue use. The logistic estimate and the current valuation were used to estimate a total and marginal benefit function for alternative flow levels. This approach is appealing in that it provides a fairly robust framework for the valuation-flow relationship. The logistic function is of course constrained between 0 and 1.0; when combined with current trip valuation the result is 0 total value at near zero flow levels and a current (maximum) value at some higher flow. This has a certain practical appeal in that in fact river recreation use (and hence valuation) does go to zero below a certain level of flows. This approach, by contrast with the other referenced studies, focuses on quantity alone. The general method could be improved by combining it with CVM valuation of quality change.

Of the general procedures developed to date for instream flow valuation, the general Narayanan framework is best suited to the needs of this study. Given that the survey is by necessity cross-sectional rather than over time, variation in flows (and the consequent effects on use) can not be directly observed. Even if use was observed over the course of a given year, the range of possible flows which are of greatest interest for the reservation process (those below the DFWP instream flow request) may not be observed on many streams. Following Narayanan's general approach, a logistic relationship between flow and use can be derived from a mail survey.

A brief description of the Narayanan (1986) approach is as follows. Visitors were asked to indicate at what percentage of current instream flows they would cease to visit the site for the entire season. The percentages given as options were 0, 10, 25, 33, 60, 67, 75, and 100; these 8 flow levels can be designated as F_i. The 100 percent option corresponded to the average streamflow for the sample season (summer of 1982, in this case). Based on survey responses, the proportion of visitors at each flow level (or $P(F_i)$) was computed. The logistic function was used to model the relationship of participation and flow:

$$13)\qquad P(F_i) = \frac{1}{1 + \exp -(a + b F_i)}$$

For estimation purposes, this can be transformed to a linear function of flow:

$$14)\qquad \log(P/(1-P)) = a + b F_i$$

Narayanan apparently used ordinary least squares (OLS) to estimate this equation. Maximum likelihood procedures or weighted least squares are an alternative. The former is inappropriate because the observations are not entirely independent; the latter is the usual correction for heteroscedasticity, which occurs in cases where a proportion is included in the specification. Heteroscedasicity means that the variance of the disturbance term is not constant. Given the nature of the data, we also chose to use OLS.

Given a measure of total recreational benefits B at current (100 percent) flow levels, total benefits as a function of flow are simply:

15) $B(F_i) = P(F_i)\ B$

Narayanan used a travel cost model to derive current recreational benefits, but these could just as well come from a CVM model. Given equation (15), a schedule of total benefits as a function of flow levels can be computed. To derive the marginal value of a given increment of stream flow, equation (15) is differentiated with respect to flow. This yields the change in total value for a unit (one percent) change in flow. The marginal value can be converted to dollars per acre foot by multiplying the first derivative by 100 over current discharge or (100/D). The marginal value is then given by:

16) $MV(F_i) = (100/D)\ B\ b\ (\exp -(a + b\ F_i)/[1 + \exp -(a + b\ F_i)]^2$

A limitation of this approach is that only the relationship between decrements to flow and use can be derived. This would be a problem in a low water year. Given that the policy issue at hand concerns the valuation of decreases rather than increases in flow, the method is appropriate. As Narayanan notes, the success of this approach depends on how accurately respondents perceive the options in flow levels and are able to evaluate the impact on their recreational experience. To address this potential problem, respondents were asked to rate themselves on how knowledgeable they were about the effect of flow on a given river.

The application at hand is somewhat more complex than the Narayanan case in that valuation is for an entire year and for subbasins, individual waters or groups of waters within an entire river basin. The model can be extended to multiple sites and time periods by indexing the discharge, valuation, and flow variables to specify site, time period and flow or $D_{jt}(F..)$, $MV_{jt}(F..)$ and F_{ijt} where there are i discrete flow levels, j sites and t discrete time periods per year. This raises the additional complication of selecting the level of site and time period aggregation.

Choice of site aggregation is necessary when estimating the participation-flow response function (equation (15)). This choice is in part determined by sample size; one would want to group waters and respondents that might have homogeneous responses - for example rivers versus reservoirs and residents versus nonresidents. Given sample limitations, it may be necessary to develop generic response functions for water types and large site groups.

Choice of time period aggregation is also very important. Narayanan estimated the value of summer recreation and compared this to the change in summer flows. By comparison, using our year total values and year total discharges could be misleading in that average values over the year would certainly understate

summer values (when recreation use is concentrated) and overstate winter values. There are three considerations that relate to the appropriate time period choice: opportunity cost, potential demand, and discharge levels.
When the opportunity cost of instream flows is zero, the marginal value of flows is not of much interest. This situation holds when no other uses are competing with instream flows (for example during typical June high flows). The periods when instream flows potentially compete with other uses are during low flow periods when both recreational use and consumptive uses such as irrigation are high - for example during July and August. July and August are also months that are fairly homogeneous with regard to potential use levels - many individuals take vacation during this period, the weather might be nice, and school is out. One wouldn't want to group January and August in that the relationship of potential use and flow are likely to be very different during those months. Finally, the estimated participation-flow relationships are most meaningful if the "current flow" corresponding to the trip surveyed is at about the same level for all respondents. This provides some validity for using the 0 to 100 percent flow index with a given discharge level. In general, most Montana streams change from high to moderate or low flows between June and July.

These considerations suggest modeling (to the extent data permits) the July-August time period separately from the rest of the year.

Use of a mail survey and basin or subbasin level sites introduces some problems for estimating the recreational value of instream flows in that actual variation in use at a given site is not directly observed and sites that are grouped may not be similar. We used a modified Narayanan approach that disaggregates by July-August and rest-of-year time periods. We also dissaggregated by site and water type (reservoirs versus streams) and subbasin level to have more homogeneous site groupings.

EXISTENCE VALUES OF INSTREAM FLOWS

The preceding discussion of the value of instream flows is limited to direct recreational use. However, as first suggested by Krutilla (1967), individuals may place value on the existence of natural environments or wildlife species independent of their own personal use. For example a person may value knowing that a unique environment like the Grand Canyon or an endangered species such as the whooping crane exists, even though they have no hope or desire to visit or see these resources. The fact that people will donate to trust funds (such as the World Wildlife Fund or The Nature Conservancy) for protecting rare species and environments is evidence of existence values. Existence values may be motivated by altruism, concern for future generations, by stewardship, or by consideration of other individuals' use. Existence values are also sometimes called intrinsic, nonuse or preservation values.

The combination of direct use and existence value is referred to as the total value of a given wildlife resource (Randall and Stoll, 1983). The estimation of existence values for river environments is fairly new, though there have been applications by Sutherland and Walsh (1985) for valuing the Flathead River and Lake, by Walsh, Sanders and Loomis (1985) for valuing wild and scenic rivers in Colorado, and by Duffield, Butkay and Allen (1990) for valuing instream flow improvements on five Montana rivers. To date there have also been several estimates of the total value of specific wildlife resources or habitats including a study of whooping cranes (Bowker and Stoll (1988), bighorn sheep and grizzly bears in Wyoming (Brookshire, Eubanks and Randall, 1983), bald eagles and striped shiners in Wisconsin (Boyle and Bishop, 1987), desert bighorn sheep (King, Flynn and Shaw 1988) and elk winter range for the Northern Yellowstone elk herd (Duffield, 1989). However, by comparison with the large number (120) of direct recreational value studies identified by Walsh, Johnson and McKean (1988), to date relatively little effort has been directed toward existence values for wildlife or unique environments.

The usual approach in these studies is to use contingent valuation with a hypothetical trust fund payment vehicle. This approach is also used here, with an application of the dichotomous choice contingent valuation model described above. Unlike surveys limited to recreational valuation (which can be conducted on-site), a household mail sample is needed to estimate existence values. This is because both users and nonusers may place existence values on a given resource. The application here is somewhat unique in that no studies directed specifically at the existence or total values of instream flows have been published to date. A description of the detailed approach and discussion of the trust fund survey question is in Chapter VI below.

A complication associated with this study, again because of multiple sites, is that it is difficult to describe for the respondent the increment to instream flows that would be associated with a given trust fund donation. Because of this, the hypothetical situation described is necessarily vague and generic. This limits the possibility of comparing the total and existence valuation estimates from the trust fund section with the recreational value of a given flow increment using the Narayanan method.

Chapter III

DATA SOURCES

The data used in this study came from three sources. All net willingness to pay figures, descriptive statistics and flow valuation statistics were drawn from a mail survey administered by the Department of Natural Resources and Conservation during the summer and fall of 1989. A phone survey of nonrespondents was also conducted in the fall of 1989. The extensive data collected by this DNRC survey was supplemented with estimates of statewide fishing pressure provided by the Department of Fish, Wildlife and Parks from it's 1985 statewide angler pressure survey. (Survey questionnaires are displayed in Appendix A).

In order to sample more efficiently the DNRC survey used a stratified sample. A total of 9000 questionnaires were mailed; 2000 to residents of each of three subbasins of the Missouri River system (upper, middle and lower), 2000 to Montana residents living outside the Missouri River basin and 1000 to holders of nonresident conservation licenses. The pool of nonresident license holders is representative of those nonresidents coming to the waters of the Missouri River basin to fish.

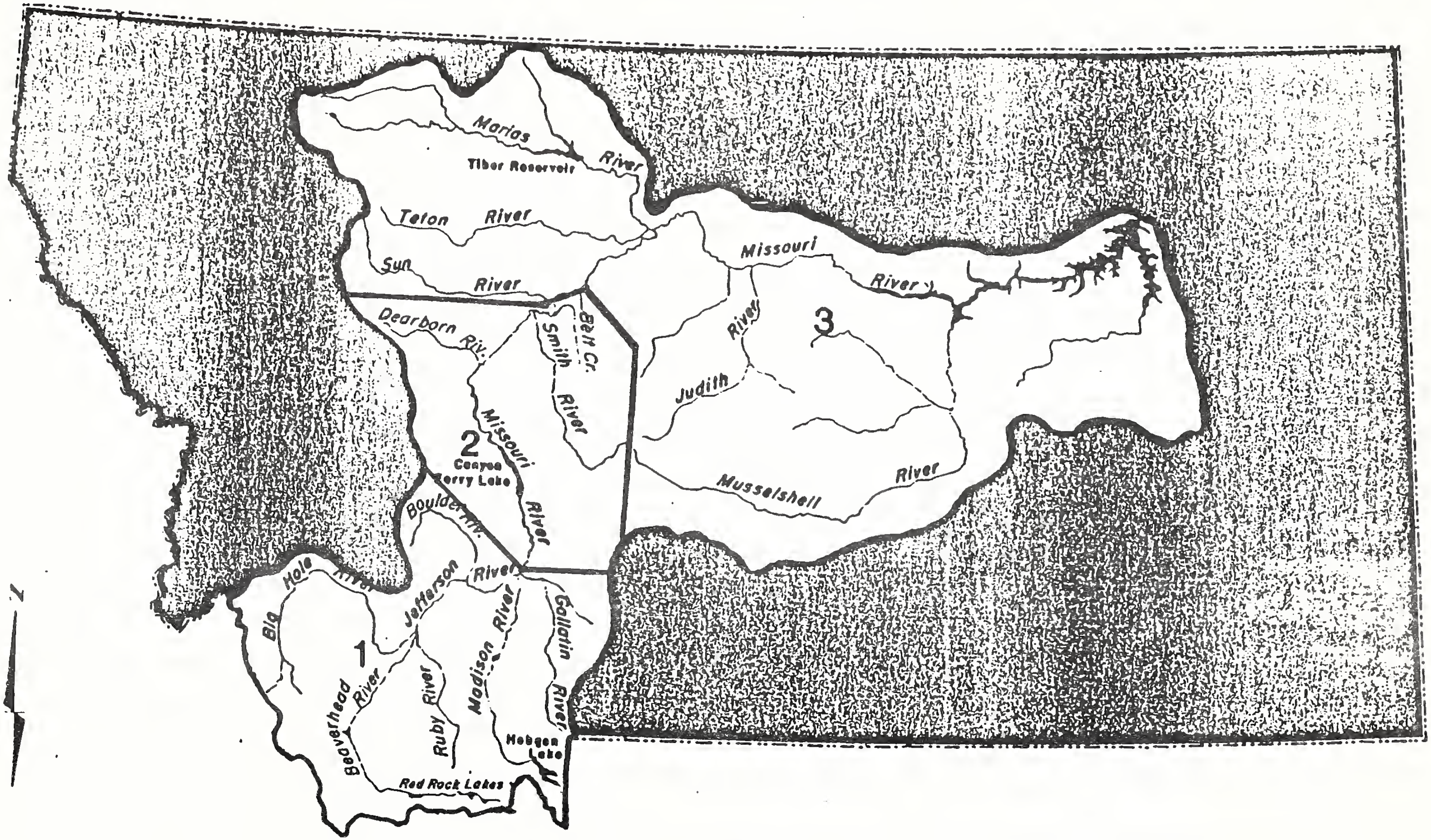
An adaption of Dillman's (1978) Total Design Method was used to conduct the mail survey. A questionnaire booklet, cover letter, and an addressed, stamped return envelope was mailed to the sample. A postcard reminder was sent one week later.(Appendix A) Two weeks after that, a follow-up letter and a second copy of the booklet were sent to those people not yet responding. Previous experience indicated that a 30 to 40 percent response rate could be expected from a general household mailing such as this. The actual response rate for this study was slightly better than expected with 3845 of the 7061 delivered surveys being returned for a 54% response rate. The response rate was the same for residents and nonresidents. The completed surveys were coded and entered into data files under the direction of DNRC.

In order to estimate recreational use on the streams and reservoirs of the Missouri Basin the information collected by the DNRC survey was supplemented with estimates of statewide angler use compiled by DFWP.

In 1985 the Montana Department of Fish Wildlife and Parks conducted an extensive mail survey to estimate fishing pressure on Montana's sport fishing waters. This survey was a continuation of a yearly fishing pressure survey begun in 1982 and scheduled to end in 1986. For 1985, however, the sampling rate was doubled over the preceding three years in order to provide a more accurate data base for the Montana Bioeconomic Project's study of Montana fishing values. In 1985

Figure 1

MISSOURI RIVER BASIN WATERWAYS



1 = Upper Subbasin
2 = Middle Subbasin
3 = Lower Subbasin

approximately 36,000 surveys were mailed to anglers. Of the 19,271 surveys returned 5,984 said they had fished during the time period in question and provided information on when and where they fished. The data from this survey was used to estimate total fishing pressure on the streams and reservoirs in the Upper Missouri Basin. When combined with DNRC data on the percentage of recreationists who were anglers a comprehensive picture of recreational use in the Missouri Basin emerges.

Nonresponse Analysis

A phone survey of 150 resident nonrespondents was conducted after the completion of the mail survey in order to examine nonresponse bias. The phone survey script is provided in Appendix A. While the nonrespondent data was not used to make adjustments in use and valuation estimates in this study, it is instructive to examine the nonresponse data for indications of possible bias in the respondent survey data. Table 1 shows a comparison of respondent to nonrespondent mean values for selected attributes. Both participation in water-based recreation and number of days engaged in water-based recreation are lower for the nonrespondent sample. This indicates the original survey respondents are more active in water recreation and thus their responses might bias the estimates herein upward. Since, however, use days as estimated in the following chapter are based on DFWP estimates of angler days rather than on this survey the bias should be a small one. Indicative of a much lower interest in outdoor recreation in general is the mean participation rate in sportsmans organizations for the nonrespondents. This rate of 3.4% compared to 18.5% for respondents is sizable. Again this could indicate an upward bias in the estimates to follow. Estimates for age and education (an index of discrete educational levels) are similar for both respondents and nonrespondents. Finally, Females made up a much larger percentage of nonrespondents than of respondents. The effect of this difference upon the following estimates is indeterminate.

Table 1

Comparison of Respondent and Nonrespondent Means

Attribute	Respondents (Std.Dev.)	Nonrespondents (Std.Dev.)
% Participating in Water-Based Rec.	85.5 (32.5)	72.8 (44.6)
Number days per year of Water Recreation	20.4 (26.3)	12.9 (15.5)
% who are Member of a Sportsmans Organization	18.5 (38.8)	3.4 (18.2)
Average Age	46.3 (16.4)	45.8 (16.8)
Average Education**	5.06 (1.43)	4.89 (1.41)
% Female	41.0	58.8

** Average education was coded as a continuous variable ranging from 1 to 8 according to the following scheme: some grade school=1, finished grade school=2, finished junior high=3, finished high school=4, some college=5, finished college=6, some postgraduate=7 and finished postgraduate=8.

Chapter IV

DESCRIPTIVE STATISTICS AND USE LEVELS

This chapter provides a summary of responses to survey questions dealing with characteristics of respondents, the trips they took and overall levels of use and expenditures on those trips. All major statistics are presented both for the Montana resident population and the nonresident angler population.

Characteristics of Recreationists

A large percentage of Montana residents participate in water-based recreational activities such as fishing, boating, or shoreline activities like picnicking, swimming, sightseeing or camping. Of the resident respondents to the Missouri River survey 83.5% said they participated in one or more of these activities. Since the nonresident subsample was limited to anglers 100% of this group by definition participated in water-based recreation. The high percentage of resident use indicates the importance of Montana streams and reservoirs to the recreational experiences of those living in the state.

Three questions were posed to survey respondents regarding their attitudes about water, its quality and uses. The questions asked respondents to indicate whether they strongly agreed, agreed, disagreed, strongly disagreed with or had no opinion about statements regarding water. The responses of those who either strongly agreed with or agreed with the statements are presented in Table 2.

Table 2
Percentages of Respondents Either Strongly Agreeing or Agreeing With Statements on Water Use

	Residents	Nonresidents
A. I enjoy knowing that my friends and family can visit rivers for recreation if they want to.	97.4%	99.2%
B. Water quality in rivers and streams in this area of Montana should be improved.	79.7%	65.8%
C. I think irrigation is the most important use of Montana's water.	44.0%	20.6%

A clear trend emerges from the reactions to these statements. Water, and the role it plays in recreation is very important to both Montanans and nonresidents as well. It is also interesting that the dominant consumptive water use in Montana (irrigation) is perceived as the most important use of that water by only 44% of residents and only 20.6% of nonresident anglers.

A number of demographic questions were asked of people receiving the surveys. The responses to these demographic questions were analyzed as covariates in the multivariate logistic regression models in order to better explain the economic behavior of respondents. These responses are also interesting in that they paint a composite picture of the respondents. Table 3 presents the statistics from these demographic variables.

Table 3

Demographic Variables for Residents and Nonresidents

	Residents	Nonresidents
% who belong to a conservation, fishing or boating organization.	15.4%	38.6%
% who live in rural areas	28.5%	25.5%
% of respondents who are female	41.0%	17.6%
% with at least a high school education	92.1%	95.0%
% with at least an undergraduate degree	60.9%	74.5%
Average number of days per year spent in water-related recreation	20.3	21.1
Average number of years spent in water-related recreation	28.7	23.7
Average age of respondents	46.6	44.3
Average yearly family income	$ 28,725	$ 49,129

Characteristics of Recreational Trips

In addition to questions about the individuals completing the surveys, several questions were asked about recent recreational trips which they had taken. The questionnaire focused on trips made in 1989, and specifically on one trip made during the year. Table 4 summarizes the responses to a series of questions on 1989 trips.

Table 4

Trip Characteristics for Residents and Nonresidents Who had Taken a Recent Trip

	Residents (Std.Dev.)	**Nonresidents (Std. Dev.)**
Average number of days of current trip	3.09 (11.1)	4.36 (7.69)
Trips so far this year to this area	6.68 (14.1)	2.02 (2.63)
Years visiting this area	16.29 (13.4)	6.70 (7.83)
% who were either knowledgeable or very knowledgeable of water level effects	52.2%	36.2%
% who either knew exactly or had a general idea of water level before trip.	72.8%	58.6%
% who preferred a higher level	31.9%	24.5%
% who preferred a lower level	2.1%	7.3%

Recreational Use Statistics

One of the major objectives of this study was the estimation of total recreational use on the streams and reservoirs of the Missouri River basin. Two components were used in order to arrive at these estimates; DNRC estimates of the percentage of recreationists who were anglers, and DFWP estimates of total angler use on individual streams and reservoirs. Since the two studies were performed in different years (DFWP 1985, DNRC 1989) sales of resident and nonresident fishing licenses for 1985 and 1989 were examined to determine if the 1985 DFWP fishing pressure estimates could still be considered valid for 1989. It was found that total resident and nonresident fishing license sales increased by 1.3% from 1985 to 1989. This suggests that the use of the 1985 fishing pressure estimates will provide a slightly conservative estimate of 1989 angler use. This conservative approach is consistent with the desired goal of determining a defensible lower bound for use and valuation estimates.
The DFWP pressure data classifies waters into major drainages. These major drainages may contain several large rivers or streams. Table 5 details which major rivers and streams are included in the DFWP drainage classifications. It should be noted that estimated angler use includes not only use on the rivers and streams listed but on all tributaries of those waters as well.

Table 5

Major Rivers and Creeks Included in DFWP Drainage Classifications

Subbasin	DFWP Drainage	Included Waters
Upper	Beaverhead	Mainstem Beaverhead River Ruby River Red Rocks River
	Bighole	Bighole River Wise River
	Gallatin	Gallatin River
	Jefferson	Jefferson River Boulder River
	Madison	Madison River
Middle	Upper Missouri	Mainstem Missouri River from Three Forks to Marias River Dearborn River Smith River Belt Creek
Lower	Marias	Marias River Teton River
	Lower Missouri	Mainstem Missouri River from Marias River to Fort Peck Dam Judith River
	Musselshell	Musselshell River
	Sun	Sun River

Tables 6, 7 and 8 detail the DFWP fishing pressure estimates for specific drainages or waters. These tables include estimates of the standard errors associated with the pressure estimates.

Table 6 shows total number of angler use days for rivers and streams in the Missouri River Basin. The estimates of angler use are presented for residents, nonresidents and for all anglers combined. Table 7 presents the same statistic, but this time for use on all reservoirs within the basin. The estimates are again presented for both residency classes. Table 8 presents a breakdown of angler reservoir use into individual major reservoirs.

Table 9 was aggregated from Tables 6 and 7. Table 9 presents the level of detail in which expenditure, trip valuation and flow valuation estimates will be presented. Statistics are presented for four types of use (resident rivers and streams, nonresident rivers and streams, resident reservoirs and nonresident reservoirs), and for three areas of use (Upper Missouri Subbasin, Middle Missouri Subbasin and Lower Missouri Subbasin). The Upper Missouri Subbasin includes all reservoirs and tributaries of the Missouri River upstream of Three Forks Montana. The Middle Subbasin includes waters and tributaries between Three Forks and the mouth of the Marias River. The Lower Subbasin includes waters between the Marias River and Fort Peck Dam.

In order to compute total recreational use on the streams and reservoirs of the Missouri River Basin the angler use statistics presented thus far needed to be expanded to include user groups besides anglers. The DNRC survey asked respondents several questions about one recent trip. Among those questions was one asking recreationists to indicate what the main activity was that they engaged in on this trip. Choices included fishing from shore, fishing from a boat, boating or floating and shoreline recreation (picnicking, sightseeing, camping or swimming). The first two categories (both fishing) were summed in order to determine the proportion of respondents who were engaged in fishing as a main activity. Tables 10, 11, 12 and 13 present these angler proportions for several levels of aggregation. Also presented in these tables are standard errors and sample sizes for the estimated proportions.

Table 10 is the parallel angler proportion table to angler use Table 9. Table 11 provides angler proportions compatible with Table 6's use statistics. Table 12 is the proportion counterpart to Table 8's angler use days. Table 13 is presented to provide information on how types of recreational use vary across subbasins, residency classes and water types. In some cases where samples are small the standard errors are large relative to the estimate, indicating that the estimates are imprecise.

Table 6

Angler Use Days 1985
River and Stream Subsample

Subbasin	Drainage	Residents (Std.Err)	Nonresidents (Std.Err)	Total (Std.Err)
Upper	Beaverhead	28,739	21,859	50,593
		(3405)	(1823)	(3863)
	Big Hole	50,990	16,638	67,628
		(6086)	(2522)	(6588)
	Gallatin	52,993	31,936	84,929
		(6640)	(11552)	(13324)
	Jefferson	26,788	3,261	30,049
		(3624)	(807)	(3714)
	Madison	39,506	82,349	121,855
		(6149)	(13476)	(14813)
Middle	Upper Missouri*	179,756	14,850	194,606
		(11942)	(1768)	(12072)
Lower	Marias	9,026	561	9,587
		(1893)	(250)	(1909)
	Lower Missouri	33,339	3,668	37,007
		(5185)	(788)	(5244)
	Musselshell	14,547	1,684	16,231
		(3102)	(459)	(3136)
	Sun	10,191	946	11,137
		(2210)	(406)	(2247)
	Total	**445,875**	**177,753**	**623,628**
		(18201)	**(18154)**	**(25,706)**

Source: Montana Dept. of Fish Wildlife and Parks 1985 Fishing pressure data.

*Includes mainstem Dearborn, (1246 total days), mainstem Smith, (11,824), Mainstem Belt Creek, (8645), the Missouri River from Three Forks to Marias River, (132,715), and Hound Creek, (1446).

Table 7

Angler Use Days 1985
Reservoirs

Subbasin	Drainage	Residents (Std.Err)	Nonresidents (Std.Err)	Total (Std.Err)
Upper	Beaverhead	23,836 (4158)	17,087 (1908)	40,923 (4575)
	Big Hole	0	0	0
	Gallatin	3,570 (878)	68 (68)	2,638 (881)
	Jefferson	9,055 (1843)	0	9,055 (1843)
	Madison	13,353 (3372)	34,119 (9382)	47,472 (9969)
Middle	Upper Missouri	184,942 (21305)	9,969 (1965)	194,911 (21396)
Lower	Marias	38,769 (10612)	273 (136)	39,042 (10613)
	Lower Missouri	41,315 (5452)	1530 (643)	42,845 (5490)
	Musselshell	22,769 (3520)	685 (274)	22,959 (3531)
	Sun	30,337 (13754)	733 (285)	31,070 (13758)
	Total	**366,451** **(28821)**	**64,464** **(9804)**	**430,915** **(30443)**

Source: Montana Dept. of Fish Wildlife and Parks 1985 Fishing pressure data.

Table 8

Angler Use Days 1985
Selected Major Reservoirs

Subbasin	Drainage	Residents (Std.Err)	Nonresidents (Std.Err)	Total (Std.Err)
Upper	**Beaverhead**			
	Clark Canyon Res.	20,812 (4022)	15,088 (1758)	35,900 (4389)
	Ruby River Res.	1,700 (710)	828 (514)	2,528 (876)
	Madison			
	Ennis Lake	1,198 (510)	1,644 (820)	2,842 (966)
	Hebgen Lake	12,155 (3333)	32,475 (9346)	44,630 (9922)
Middle	**Upper Missouri**			
	Hauser Res.	22,637 (4068)	543 (250)	23,186 (4076)
	Holter Res.	72,342 (18408)	3356 (842)	75,699 (18427)
	Lake Helena	3,416 (1394)	0	3,416 (1394)
	Canyon Ferry Res.	70,657 (9500)	5378 (1738)	76,035 (9657)
Lower	**Lower Missouri**			
	Fort Peck Res.	36,155 (5161)	1256 (582)	37,411 (5194)
	Marias			
	Lake Elwell	15,947 (3510)	205 (118)	16,152 (3512)
	Sun			
	Gibson Res.	1,582 (1422)	137 (137)	1,719 (1428)
	Musselshell			
	Deadmans Basin	11,404 (2615)	548 (256)	11,952 (2628)
	Martinsdale Res.	10,528 (2342)	137 (97)	10,665 (2344)

Source: Montana Dept. of Fish Wildlife and Parks 1985 Fishing Pressure data.

Table 9

Total Angler Use Days 1985
By Subbasin

	Rivers and Streams		Reservoirs		All	
Subbasin	Res.	Nonres.	Res.	Nonres.	Res.	Nonres.
Upper	199,016 (11986)	156,043 (18038)	49,814 (5729)	51,274 (9574)	248,830 (13,285)	207,317 (20,421)
Middle	179,756 (11,942)	14,850 (1768)	184,942 (21305)	9,969 (1965)	364,698 (24,423)	24,819 (2643)
Lower	67,103 (6706)	6,859 (1029)	133,190 (18545)	3,221 (767)	200,293 (19,720)	10,080 (1283)
TOTAL	445,875 (18201)	177,753 (18154)	367,946 (28821)	64,464 (9804)	813,821 (34,087)	242,217 (20,632)

Source: Montana Dept. of Fish Wildlife and Parks 1985 Fishing pressure data.

Table 10

Angler Proportion of Total Use 1989

	Rivers and Streams		Reservoirs		Total	
Subbasin	Res.	Nonres.	Res.	Nonres.	Res.	Nonres.
Upper						
Proportion	.481	.876	.605	1.00	.488	.901
(S.E.)	.025	.031	.104	.00	.024	.025
[N]	397	110	22	28	419	138
Middle						
Proportion	.438	.923	.504	.872	.494	.885
(S.E.)	.053	.074	.023	.054	.021	.045
[N]	86	13	468	38	554	51
Lower						
Proportion	.281	.700	.476	.645	.384	.666
(S.E.)	.034	.205	.035	.169	.025	.131
[N]	176	5	199	8	375	13
All						
Proportion	.417	.859	.499	.896	.455	.859
(S.E.)	.017	.028	.019	.035	.014	.024
[N]	659	128	689	74	1348	202

Note: Proportions may not be an even fraction of sample size, due to the problem of respondents marking multiple activities as their main activity.

Table 11

Angler Proportion of Total Use 1989
By Drainage
River and Stream Subsample

Subbasin	Drainage	Residents (Std.Err) [N]	Nonresidents (Std.Err) [N]	Total (Std.Err)[N]
Upper	Beaverhead	.622 (.110) [49]	.955 (.047) [19]	.731 (.082) [72]
	Big Hole	.495 (.057) [107]	.782 (.107) [23]	.546 (.053) [130]
	Gallatin	.537 (.051) [94]	.832 (.167) [21]	.552 (.049) [99]
	Jefferson	.314 (.109) [35]	1.00 (0.00) [2]	.351 (.109) [37]
	Madison	.412 (.047) [112]	.877 (.043) [57]	.569 (.032) [169]
Middle	Upper Missouri[•]	.411 (.048) [305]	.832 (.079) [38]	.457 (.045) [345]
Lower	Marias	.154 (.057) [64]	--	.154 (.057) [64]
	Lower Missouri	.385 (.039) [253]	.786 (.082) [25]	.421 (.037) [278]
	Musselshell	.475 (.096) [27]	1.00 (.000) [1]	.494 (.094) [28]
	Sun	.359 (.077) [39]	.500 (.354) [2]	.366 (.075) [41]

Note: Missing cells indicate no nonresident use was observed in the sample population

[•] Includes mainstem Dearborn, mainstem Smith, mainstem Belt Creek, the Missouri River from Three Forks to Marias River, and Hound Creek.

Table 12

Angler Proportion 1989
Selected Major Reservoirs

Subbasin	Drainage	Residents (Std.Err) [N]	Nonresidents (Std.Err) [N]	Total (Std.Err) [N]
Upper	**Beaverhead**			
	Clark Canyon Res.	.721 (.129) [12]	1.00 (.000) [18]	.889 (.057) [30]
	Madison			
	Hebgen Lake	.466 (.158) [10]	1.00 (.000) [10]	.733 (.099) [20]
Middle	**Upper Missouri**			
	Hauser Res./ Holter Res.	.599 (.035) [195]	.896 (.076) [16]	.621 (.033) [211]
	Canyon Ferry Res.	.429 (.030) [268]	.855 (.075) [22]	.461 (.029) [290]
Lower	**Lower Missouri**			
	Fort Peck Res.	.431 (.045) [121]	.645 (.169) [8]	.444 (.044) [129]
	Marias			
	Lake Elwell	.523 (.226) [65]	--	.523 (.226) [65]
	Musselshell			
	Deadmans Basin	.583 (.201) [6]	--	.583 (.201) [6]

Note: Missing cells indicate no nonresident use was observed in the sample population.

Table 13
Proportion of Total Use 1989
By Activity and Subbasin

	Rivers and Streams		Reservoirs	
Subbasin	Res.	Nonres.	Res.	Nonres.
Upper Subbasin				
[N]	397	110	22	28
Anglers				
Proportion	.481	.876	.605	1.00
(S.E.)	.025	.031	.104	.00
Float/Boat				
Proportion	.147	.035	.106	.00
(S.E.)	.018	.017	.066	.00
Shoreline				
Proportion	.372	.089	.288	.00
(S.E.)	.024	.027	.097	.00
Middle Subbasin				
[N]	86	13	468	38
Anglers				
Proportion	.438	.923	.504	.872
(S.E.)	.053	.074	.023	.054
Float/Boat				
Proportion	.165	.077	.184	.024
(S.E.)	.400	.074	.018	.025
Shoreline				
Proportion	.397	.000	.311	.103
(S.E.)	.053	.000	.021	.051
Lower Subbasin				
[N]	176	5	199	8
Anglers				
Proportion	.281	.700	.476	.645
(S.E.)	.034	.205	.035	.169
Float/Boat				
Proportion	.132	.000	.154	.166
(S.E.)	.026	.000	.026	.132
Shoreline				
Proportion	.587	.300	.370	.188
(S.E.)	.037	.205	.034	.138

Table 14

Proportion of Total Use 1989
Entire Basin

	Rivers and Streams		Reservoirs	
	Res.	Nonres.	Res.	Nonres.
Anglers				
Proportion	.417	.859	.499	.896
(S.E.)	.016	.028	.019	.035
Float/Boat				
Proportion	.166	.041	.173	.030
(S.E.)	.012	.016	.014	.020
Shoreline				
Proportion	.417	.099	.327	.073
(S.E.)	.016	.024	.018	.030

The estimates for total angler use days from DFWP and angler proportion of total use from this survey were combined to arrive at estimates of total recreational use days. This was done by simply dividing total angler use days by total angler proportion These total use estimates are presented in Tables 15, 16, and 17. Again, standard errors for the estimates are presented along with the estimated totals. The specific equations used in the calculation of all estimates and standard errors are presented in Appendix B.

Table 15 shows that a total of over 2 million recreational use days occurred on waters of the Missouri basin in 1989. Of this total approximately 86% was resident use and 14% nonresident. The use was divided with 61% occurring on rivers and streams and 39% on reservoirs. Table 16 presents the total use statistics for rivers and streams in a more disaggregated manner. Likewise, Table 17 shows total recreational use for specific reservoirs in the Missouri basin.

A final set of tables on recreational use in the Missouri River Basin makes explicit the standard errors presented along with the use estimates. Tables 18 and 19 show the 95% confidence intervals for the DFWP angler use days estimates shown in Tables 6 and 7. That is, these tables present the range of possible angler use for the DFWP estimates + or - 1.96 times their standard errors. Tables 20 and 21 present these confidence intervals for the total recreational use estimates of Table 14.

Table 15

Estimated Total Recreational Use Days 1989
By Subbasin

	Rivers and Streams		Reservoirs		Total	
Subbasin	Res. (S.E.)	Nonres. (S.E.)	Res. (S.E.)	Nonres. (S.E.)	Res. (S.E.)	Nonres. (S.E.)
Upper	413,755	178,131	82,337	51,274	509,898	230,097
	(32,915)	(21,535)	(16,794)	(9574)	(36,944)	(23,547)
Middle	410,402	16,089	366,948	11,432	738,255	28,044
	(56,653)	(2309)	(45,468)	(2362)	(58,559)	(3309)
Lower	238,801	9,799	279,811	4,994	521,596	15,135
	(37,475)	(3224)	(44,023)	(1768)	(61,520)	(3546)
TOTAL	**1,069,732**	**206,846**	**737,366**	**71,940**	**1,788,617**	**277,987**
	(61,689)	**(22,184)**	**(64,170)**	**(11,297)**	**(92,898)**	**(25,278)**

Table 16

Estimated Total Recreational Use in Days 1989
By Drainage
River and Stream Subsample

Subbasin	Drainage	Residents (Std.Err)	Nonresidents (Std.Err)	Total (Std.Err)
Upper	Beaverhead	46,204 (9835)	22,889 (2216)	69,210 (9391)
	Big Hole	103,010 (17,084)	21,276 (4344)	123,860 (17,033)
	Gallatin	98,683 (15,515)	38,385 (15,879)	153,857 (27,733)
	Jefferson	85,312 (31,784)	3261 (807)	85,609 (28,613)
	Madison	95,888 (18,504)	93,899 (16,040)	214,156 (28,684)
Middle	Upper Missouri*	437,362 (58,764)	17,849 (2714)	425,834 (49,558)
Lower	Marias	58,610 (24,934)	--	62,253 (26,164)
	Lower Missouri	86,595 (16,072)	4,667 (1114)	87,903 (14,657)
	Musselshell	30,625 (8998)	1,684 (459)	32,856 (8910)
	Sun	28,387 (8658)	1,892 (1566)	30,429 (8751)

---

* Includes mainstem Dearborn, mainstem Smith, mainstem Belt Creek, the Missouri river from Three Forks to Marias River, and Hound Creek.

Note: Missing cells were not calculated due to a lack of observed visitation in the sample population.

Table 17

Estimated Total Recreational Use in Days 1989
Selected Major Reservoirs

Subbasin	Drainage	Residents (Std.Err)	Nonresidents (Std.Err)	Total (Std.Err)
Upper	**Beaverhead**			
	Clark Canyon Res.	28,865	15,088	40,382
		(7602)	(1758)	(5574)
	Madison			
	Hebgen Lake	26,084	32,475	60,887
		(11,374)	(9346)	(15,838)
Middle	**Upper Missouri**			
	Hauser Res./ Holter Res.	158,563	4,352	159,235
		(32,808)	(1047)	(31,545)
	Canyon Ferry Res.	164,702	6,290	164,935
		(24,961)	(2106)	(23,377)
Lower	**Lower Missouri**			
	Fort Peck Res.	83,886	1,947	84,259
		(14,835)	(1037)	(14,373)
	Marias			
	Lake Elwell	30,491	--	30,491
		(14,835)		(14,835)
	Musselshell			
	Deadmans Basin	19,560	--	20,501
		(8099)		(8383)

Note: Missing cells were not calculated due to a lack of observed visitation in the sample population.

Table 18

Angler Use Days
95% Confidence Intervals Derived from Table 6
River and Stream Subsample

	Residents			Nonresidents		
Drainage	Lower		Upper	Lower		Upper
Upper						
Beaverhead	22,065	--	35,413	18,286	--	25,432
Big Hole	39,061	--	62,919	11,695	--	21,581
Gallatin	39,979	--	66,007	9,297	--	54,578
Jefferson	19,685	--	33,891	1,679	--	4,843
Madison	27,454	--	51,558	55,936	--	108,762
Middle						
Upper Missouri	156,350	--	203,162	11,385	--	18,315
Lower						
Marias	5,316	--	12,736	71	--	1,051
Lower Missouri	23,176	--	43,502	2,124	--	5,212
Musselshell	8,467	--	20,627	784	--	2,584
Sun	5,859	--	14,523	150	--	1,742
			Totals			
Upper Basin	175,523	--	222,509	120,689	--	191,397
Middle Basin	156,350	--	203,162	11,385	--	18,315
Lower Basin	53,959	--	80,247	4,842	--	8,876

Source: DFWP 1985 fishing pressure survey.

Table 19

Angler Use Days
95% Confidence Intervals Derived from Table 7
Reservoir Subsample

	Residents			Nonresidents		
Drainage	**Lower**		**Upper**	**Lower**		**Upper**
Upper						
Beaverhead	15,686	--	31,986	13,347	--	20,827
Big Hole		-0-			-0-	
Gallatin	1,849	--	5,291	0	--	201
Jefferson	5,443	--	12,667		-0-	
Madison	6,744	--	19,962	15,730	--	52,508
Middle						
Upper Missouri	143,184	--	226,700	6,118	--	13,820
Lower						
Marias	17,969	--	59,569	6	--	540
Lower Missouri	30,629	--	52,001	270	--	2,370
Musselshell	15,870	--	29,668	148	--	1,222
Sun	3,379	--	57,295	174	--	1,292
			Totals			
Upper Basin	37,585	--	60,043	32,509	--	70,039
Middle Basin	143,184	--	226,700	6,118	--	13,820
Lower Basin	96,347	--	169,043	1,718	--	4,724

Source: DFWP 1985 fishing pressure survey.

Table 20

Total Recreational Use Days
95% Confidence Intervals Derived from Table 15
River and Stream Subsample

Subbasin	Residents Lower		Residents Upper	Nonresidents Lower		Nonresidents Upper
Upper	349,242	--	478,268	135,922	--	220,340
Middle	299,362	--	521,442	11,563	--	20,615
Lower	165,350	--	312,252	3,480	--	16,118
All	948,822	--	1,190,642	163,365	--	250,327

Table 21

Total Recreational Use Days
95% Confidence Interval Derived from Table 15
Reservoir Subsample

	Residents			Nonresidents		
Subbasin	Lower		Upper	Lower		Upper
Upper	49,421	--	115,253	32,509	--	70,039
Middle	277,831	--	456,065	6,802	--	16,062
Lower	193,526	--	366,096	1,529	--	8,459
All	608,039	--	859,585	49,798	--	94,082

Expenditure Statistics

One measure of the economic significance of water based recreation in the Missouri Basin is the expenditures made by people engaged in that recreation. These expenditures have a distributive impact upon the areas and communities where they are made. Unlike net economic values, expenditures do not represent a societal gain, since they would be spent somewhere else if not in the Missouri Basin. Rather, they represent a transfer of expenditures from one area to another or from one type of purchase to another (in the case of nonresidents the transfer is from out of state, for residents living outside the Missouri Basin the transfer is from one area of the state to another). The average expenditure per recreational trip in the Missouri Basin is $113.49 for residents and $640.14 for nonresidents. There is some variation in average expenditures between streams and reservoirs. Residents spent $100.95 per trip for stream recreation and $125.06 for reservoir recreation. Nonresidents showed significant variation between expenditures on the two types of recreation. They spent $796.88 for stream recreation and $365.58 for reservoir recreation.

Tables 24, 25 and 26 present per trip and per day expenditure statistics. Table 24 shows per trip expenditures for the three subbasins and four classes of use. Table 25 details the average number of days per trip for the same aggregation levels shown in Table 24. Table 26 has been calculated from the previous two tables and shows average expenditures per day. For the entire sample average expenditures per day were $39.13 for residents and $158.43 for nonresidents. Again, there was some difference between expenditures on stream and reservoir recreation. Residents spent $38.09 per day for stream recreation and $39.93 for reservoir recreation. Nonresidents spent $194.36 per day on stream recreation and $92.68 on reservoirs.

It is instructive to look at the expenditure estimates of this study in comparison to other recent recreational surveys. While there is always some difficulty in comparing estimates across studies due to differing study years, populations and questions, comparison still remains a useful test of "ball park" validation. Two recent studies, the 1985 National Survey of Fishing, Hunting and Wildlife-Associated Recreation (U.S.F.W.S.,1989) and the Net Economic Value of Fishing in Montana (Duffield, Loomis, and Brooks, 1987) provide comparable expenditure statistics to the current study. In order to be comparable, however, only angler expenses were selected out of the current study . The estimates of per day angler expenditures for all fishermen and all types of waters ranged from $33.40 per day for the National Survey (Montana subsample) to $69.21 per day for the current study. A comparison was also made between the estimates of Duffield et al. (1987) and the current study for a river and stream subsample for both residents and nonresidents. These results are presented in Tables 22 and 23.

When corrected for inflation, differences in the estimates remain. The current estimates are for the Missouri Basin only, while the other estimates are for all Montana waters. Differences in their estimates may also be due to differences in study years and angler population sampled.

Another source of the differences between these estimates may be memory bias. In the current study respondents were asked to answer questions about their trip most proximate to a certain date. It may be that people tend to remember longer trips which entail more planning and greater expense when faced with this type of situation. The use of a mail survey makes it impossible to tell if this type of bias is affecting the responses.

One final potential source of bias arises from the fact that each trip in the current study is given equal weight in determining average expenditures. While this equal weighting does give an accurate average of the expenditures made on these trips, it does not allow consideration of the fact that different people take varying numbers of trips per year. The possible effect of this potential weighting bias is not clear. Determination of the existence or extent of this bias would require more detailed questions on visitation patterns than were asked in the current study.

Table 22

Comparison of Expenditure Estimates Across Studies Aggregated Sample; All Waters / All Anglers

Study	Year	Per Day Expenditure Current $	 Const. 1989 $**
National Survey of Fishing (Montana subsample)	1985	$ 33.40*	$ 38.60
Duffield et al.	1985	$ 42.21	$ 48.79
Current Study	1989	$ 69.21	$ 69.21

* Computed from total trip related fishing expenditures of $81,618,000 (National Survey) and total fishing days of 2,443,438 (DFWP, McFarland, 1989)

** Based on Consumer Price Index of 373.1 August 1989 and 322.8 July 1985

Table 23

Comparison of Per Day Angler Expenditure Estimates River and Stream Subsample

Study	Year	Per Day Expenditures Residents	 Nonresidents
Duffield et al.	1985	$ 22.31 ($ 25.79)	$ 116.37 ($ 134.50)
Current Study	1989	$ 36.15	$ 188.06

Constant 1989 dollars in parentheses.

Table 24

Per Trip Expenditures 1989
By Subbasin

	Rivers and Streams		Reservoirs		All	
Subbasin	Res. (SE)	Nonres. (SE)	Res. (SE)	Nonres. (SE)	Res. (SE)	Nonres. (SE)
Upper	97.24	772.80	150.82	258.79	100.31	666.98
	(8.07)	(66.46)	(36.99)	(14.74)	(7.91)	(57.59)
Middle	162.05	1011.31	104.75	445.33	113.49	595.48
	(40.85)	(262.35)	(7.08)	(77.62)	(8.67)	(95.36)
Lower	78.52	763.00	169.97	380.50	128.40	527.61
	(8.33)	(341.28)	(19.55)	(165.34)	(11.57)	(166.22)
All	100.95	796.88	125.06	365.58	113.49	640.14
	(7.66)	(64.14)	(7.58)	(51.69)	(5.39)	(47.22)

Table 25

Average Number of Days Per Trip 1989
By Subbasin

Subbasin	Rivers and Streams Res. (SE)	 Nonres. (SE)	Reservoirs Res. (SE)	 Nonres. (SE)	All Res. (SE)	 Nonres. (SE)
Upper	2.79 (.45)	4.05 (.28)	3.59 (.89)	3.96 (.79)	2.84 (.42)	4.02 (.27)
Middle	2.91 (.51)	4.53 (.31)	2.71 (.25)	3.75 (.81)	2.73 (.23)	3.96 (.60)
Lower	2.17 (.20)	4.00 (1.34)	4.07 (.64)	4.75 (1.69)	3.21 (.36)	4.46 (1.13)
All	2.65 (.28)	4.10 (.24)	3.13 (.25)	3.94 (.54)	2.90 (.19)	4.04 (.25)

Table 26

Average Expenditures Per Day 1989
By Subbasin

	Rivers and Streams		Reservoirs		All	
Subbasin	Res. (SE)	Nonres. (SE)	Res. (SE)	Nonres. (SE)	Res. (SE)	Nonres. (SE)
Upper	34.77 (5.71)	190.99 (16.60)	42.00 (10.18)	65.27 (7.88)	35.29 (4.95)	165.53 (15.02)
Middle	55.66 (16.63)	222.83 (55.84)	38.67 (3.97)	118.76 (26.27)	41.43 (4.17)	150.40 (28.65)
Lower	36.11 (4.69)	190.75 (78.07)	41.70 (6.32)	80.10 (26.09)	39.99 (4.45)	118.25 (33.38)
All	38.09 (4.31)	194.62 (15.73)	39.93 (3.70)	92.68 (12.29)	39.13 (2.66)	158.43 (13.49)

Note: Estimates in this table may not exactly equal Table 23 estimates divided by Table 24 estimates due to rounding.

In addition to examining how expenditures vary across subbasins and across residency classes and water types it is interesting to look at differences between levels of expenditure on different types of recreational activities. Tables 27 and 28 present expenditure estimates for these different activities. Table 27 examines average expenditure per trip by residence and by activity type. Residents spend the most per trip on fishing from boats ($143.16) and the least on fishing from shore ($103.93). Nonresident expenditures are highest for boating or floating ($814.24) and lowest for shoreline activities ($597.83).

Table 28 looks at expenditures per day for residents only. These estimates are broken down by activity type, subbasin, and water type.

Estimates of total water based expenditures in the Missouri River Basin can be estimated by multiplying total recreational use days from Table 15 by average expenditure per day from Table 26. Tables 29, 30 and 31 present these total recreational expenditures. In total approximately 113 million dollars per year is spent on Missouri Basin recreation. About 61% of this amount is spent by residents and 39% by nonresidents. Nearly 77% of the total is spent on recreation on rivers and streams. The remaining 23% is spent on reservoir recreation.

Three additional tables, 32,33 and 34 show 95% confidence intervals for the total expenditure estimates presented in Tables 29,30 and 31.

Table 27

Average Expenditure Per Trip 1989
By Activity Type

Activity	Residents (SE)	Nonresidents (SE)
Boating / Floating	120.26 (11.16)	814.24 (142.69)
Fishing From Boat	143.16 (10.09)	636.60 (70.42)
Fishing From Shore	103.93 (7.97)	613.33 (45.33)
Shoreline Activities	106.96 (4.99)	597.83 (67.54)

Table 28

Expenditure per Day by Activity Type 1989
Resident Subsample

Subbasin	Activity	Rivers and Streams Mean	N	Reservoirs Mean	N
Upper					
	Fish from Shore	25.13	172	38.55	11
	Fish from Boat	43.06	57	44.84	7
	Boating/Floating	42.36	72	82.50	3
	Shoreline Act.	32.17	173	27.57	9
Middle					
	Fish from Shore	75.49	39	33.64	109
	Fish from Boat	85.34	8	38.68	190
	Boating/Floating	44.45	16	55.02	117
	Shoreline Act.	37.44	42	30.67	198
Lower					
	Fish from Shore	41.76	54	57.26	48
	Fish from Boat	27.44	11	33.63	77
	Boating/Floating	41.55	29	41.28	44
	Shoreline Act.	29.66	117	48.48	100

Table 29

Total Recreational Expenditures
River and Stream Subsample
By Subbasin

	Rivers and Streams	
Subbasin	Residents (SE)	Nonresidents (SE)
Upper	14,386,261 (2,422,650)	34,021,240 (5,163,781)
Middle	22,842,975 (7,659,837)	3,584,443 (923,345)
Lower	8,623,104 (1,773,885)	1,869,159 (575,952)
All	45,852,340 (8,227,333)	39,474,842 (5,277,208)

Table 30

Total Recreational Expenditures
Reservoir Subsample
By Subbasin

	Reservoirs	
Subbasin	Residents (SE)	Nonresidents (SE)
Upper	3,458,154 (988,436)	3,346,654 (747,953)
Middle	14,189,879 (2,231,617)	1,357,664 (451,843)
Lower	11,668,119 (2,488,553)	400,019 (186,202)
All	29,316,152 (3,485,687)	5,104,337 (893,458)

Table 31

Total Recreational Expenditures
All Waters Combined
By Subbasin

Subbasin	Residents (SE)	Nonresidents (SE)
Upper	17,994,300 (3,003,293)	38,087,956 (5,175,318)
Middle	30,585,905 (3,855,689)	4,217,818 (917,271)
Lower	20,858,624 (3,309,635)	1,789,714 (595,088)
All	69,438,829 (5,902,524)	44,095,488 (5,289,559)

Table 32

Total Recreational Expenditures
95% Confidence Intervals Derived from Table 29
River and Stream Subsample
By Subbasin

Subbasin	Rivers and Streams					
	Residents			Nonresidents		
	Lower		Upper	Lower		Upper
Upper	9,637,867	--	19,134,655	23,900,229	--	44,142,251
Middle	7,829,694	--	37,856,256	1,774,687	--	5,394,199
Lower	5,146,289	--	12,099,919	740,293	--	2,998,025
All	29,726,767	--	61,977,913	29,131,514	--	49,818,170

Table 33

Total Recreational Expenditures
95% Confidence Intervals Derived from Table 30
Reservoir Subsample
By Subbasin

	Reservoirs					
Subbasin	Residents			Nonresidents		
	Lower		Upper	Lower		Upper
Upper	1,520,819	--	5,395,489	1,880,666	--	4,812,642
Middle	9,815,910	--	18,563,848	472,052	--	2,243,276
Lower	6,790,555	--	16,545,683	35,063	--	764,975
All	22,484,205	--	36,148,099	3,353,159	--	6,855,515

Table 34

Total Recreational Expenditures
95% Confidence Intervals Derived from Table 31
All Waters Combined
By Subbasin

Subbasin	Residents			Nonresidents		
	Lower		Upper	Lower		Upper
Upper	12,107,846	--	23,880,754	27,944,333	--	48,231,579
Middle	23,028,755	--	38,143,055	2,419,967	--	6,015,669
Lower	14,371,739	--	27,345,509	623,341	--	2,956,087
All	57,869,882	--	81,007,776	33,727,952	--	54,463,024

Chapter V

CURRENT TRIP VALUATION ANALYSIS

The total, or gross economic value of a recreational trip is made up of two components. The first, which was discussed in the preceding chapter, is the actual out-of-pocket expenditures made during the trip. The second component is the net economic value of the trip, or the extra amount a person would be willing to spend for the trip over and above what they actually must spend. This chapter describes the methodology and results of net economic valuation as it was applied to the Missouri River data.

Valuation of the Current Recreational Trip

Individuals who received the Missouri River survey were asked a number of questions about a recent trip they took to the streams or reservoirs of the basin. Questions on types of activities engaged in, preferences about water flows and expenditures made on the trip were asked. Additionally, a question designed to allow the calculation of the average net willingness to pay for the trip was asked. Before asking any of these questions however it was necessary to identify one specific trip on which to focus the questions. To achieve this the respondent was asked to identify the Missouri River Basin river or reservoir which they visited closest to a specific date. There were three possible dates asked: June 15th, July 15th or simply their most recent trip. All remaining questions in this section of the questionnaire referred to this trip.

The question designed to elicit net willingness to pay asked the recreationist to place a value on their recreational experience. This question asked:

> Suppose that your share of the expenses to visit this area increased; would you still have made the trip if your cost had been \$_X_ more?

The survey respondent could answer yes or no to this dichotomous choice CVM question. The dollar amount \$ X was one of several predetermined bid levels ranging from \$5 to \$500 for residents and from \$5 to \$2000 for nonresidents. The bid amount was varied randomly across questionnaires. For a complete discussion of the determination of bid levels, ranges, and distribution across ranges see Appendix C,"Bid Distribution Analysis: DNRC Missouri River Basin Recreation Survey"

Outlier and Protest Responses

In the analysis of CVM responses there are two groups of respondents who should be excluded from the sample before any analysis occurs. The first is that group whose willingness to pay is inconsistent with their income. The standard economic definition of demand requires both a willingness and an ability to pay. Therefore those respondents who indicate a willingness but lack the ability to pay the bid amount must be excluded as their responses do not meet the constraints of economic theory. Ability to pay was determined by first isolating those respondents answering yes to the CVM question and calculating the percentage of their income which respondents were willing to spend on Missouri Basin recreation. This was calculated as follows:

17) PERCENT = ((TOTAL + BID) * TRIPS) / INCOME

Where: TOTAL = The amount they reported spending on their most recent trip.
BID = The dollar bid level asked.
TRIPS = The number of separate Missouri Basin trips they reported taking this year.
INCOME= Their reported annual Family income.

This percentage statistic was calculated for each individual who responded yes to the bid amount asked. As an initial screening measure all cases with PERCENT > 1.0 were dropped from the sample. These individuals most obviously lack the ability to pay the stated amount. The percentages for the remaining respondents were then tabulated giving the following results.

	Mean	Std.Dev.	Mean + 3 S.D.	Skewness	Kurtosis
PERCENT	.065	.128	.4429	4.134	19.78

Since the distribution of the calculated variable PERCENT was somewhat skewed rather than normally distributed a three standard deviation interval was placed around the calculated mean in order to determine the cutoff limit for outlier exclusion. In total 26 of the 2058 responses to this question were excluded from the following economic analysis due to a reported willingness to pay which exceeded the cutoff limits.

The second group of respondents who were excluded from the analysis were those whose responses reflected a "protest" to some aspect of the simulated market. The U.S. Water Resources Council has suggested that a follow-up question be asked to each CVM question. In this survey that question was: "If no, would you have made the trip if your share of the trip expenses had been only $ 1 more?" If the respondent answered "No" to this question they were asked to explain why they wouldn't. Those respondents who indicated a valid reason for their zero willingness to pay were left in the sample. These valid reasons included:

- Respondents who could not afford a higher trip cost.
- Respondents who said they would have gone elsewhere if faced with increased trip costs.
- Respondents who indicated that the trip would just not be worth any more money.

A second group of respondents was excluded from the sample because their responses indicated they were protesting the market setup rather than legitimately considering the question which was asked. These "protest" responses included:

- Respondents who said they already paid taxes to use public resources.
- Respondents who said they were opposed to fee recreation.
- Respondents who claimed that the costs could not possibly be that high.

In total 389 of the 2038 respondents were excluded from the sample because their responses were deemed to be protest responses.

Current Trip Sample Aggregation

As has been mentioned previously, the Missouri River Survey was administered in a stratified manner consisting of 4 resident strata and 1 nonresident stratum. The standard statistical method for analyzing a stratified sample such as this is to examine each strata individually and calculate a weighted mean for the entire sample with the strata weights being the percentage of the total population which each strata represents. The ideal aggregation level for the analysis of the Missouri River Basin data would be the identification of values for the three subbasins for two water types (rivers and reservoirs), for each of the five strata. This level of analysis however would require the estimation of 30 separate models. In order to accurately interpret the goodness of fit statistics from a logistic regression model such as is employed here the sample size must be of a certain minimum size. It was found that in the case of this study that minimum was approximately 100 observations. With a total sample size of only approximately 1400 observations an alternative to the 30 ideal models had to be found.

An examination of differences across the means of estimable in-state strata showed that current trip values were not significantly different from one another. It was therefore decided to estimate six resident models for the two water types and the three subbasins. Only two nonresident models were estimated due to the limited number of nonresident observations (212). Of the eight final models (6 resident and 2 nonresident) only one, residents visiting upper subbasin reservoirs, had an insufficient sample size for the logistic regression modeling. It is felt that this final aggregation scheme provides the most useful and detailed breakdown of the data possible given the constraints of the sample size.

Functional Form

The net economic value for recreation in the Missouri Basin was determined by analyzing the respondents' yes or no answers to the CVM question. These responses were analyzed using logistic regression.

Economic theory suggests that certain variables should influence the response of an individual to a CVM question. In this study, these variables include the bid amount asked, variables measuring the quality of the trip such as length of trip, and socioeconomic variables such as income and club affiliation. For some variables, the relationship with the response should be in a certain direction. For example, it is expected that as bid increases, the probability of a "yes" response will decrease and that as income increases, the probability of a "yes" response will increase.

The following multivariate logit model was used for the current trip CVM question (see equation 6), chapter II):

$$18)\ \log(P/(1-P)) = b_0 + b_1 \log(BID) + b_2 \log(INCOME) + b_3 \log(TRIPL) + b_4 CLUB$$

where:
P = Probability of a "yes" response
BID = Dollar amount of increased trip costs the respondent was asked to pay
INCOME = Annual household income
TRIPL = Length in days of the current trip
CLUB = Dummy variable indicating whether the respondent belongs to a sportsmen's organization: 1 = belongs, 0 = doesn't belong
log = The natural logarithm of the variable

The estimated coefficients and standard errors for the model in equation 18) are shown in Table 36. In all cases, the coefficients for the independent variables had the expected sign and all variables added significantly to the model at the .05 level. These results indicate the responses are logical and consistent with economic theory.

Benefit Estimation

For benefit estimation, the bivariate logit model in equation 4) of Chapter II was used:

$$\log(P/(1-P)) = b_0 + b_1\log(BID).$$

Summary statistics for this model are reported in Table 35. This model was used instead of the multivariate model of equation 18) because inclusion of covariates is useful only if the WTP distribution cannot be adequately modeled with the bivariate specification. As indicated in Table 35, the bivariate models fit the data quite well. This indicates that the WTP distribution can be well-approximated without covariates which substantially simplifies computation and interpretation of benefit estimates.

Two measures of benefit per trip were calculated from the bivariate logit models and are presented in Table 37. They are the median and the truncated mean (Chapter II). The truncation point used for the truncated mean was the maximum bid -- $500 for residents and $2000 for nonresidents. The truncated mean was calculated by numerical evaluation of the integral in equation 9), since this integral cannot be evaluated analytically for the model of equation 4) with log(bid) as the independent variable. The truncated means for residents and nonresidents are not directly comparable because of the differing truncation points, but both represent conservative estimates of the true mean benefit per trip. The median is the point at which the estimated probability of responding "yes" equals .5; the median values for residents and nonresidents can be compared, but cannot be aggregated (Chapter II).

As a comparison, truncated means were calculated for the multivariate models in Table 36 by substituting the sample mean values for INCOME and TRIPL into equation 18). These represent the estimated benefit for an average individual, which is not necessarily the same as the average benefit over all individuals. These were, in general, very close to the truncated means from the bivariate models lending credence to the hypothesis that exclusion of covariates was not biasing the truncated mean benefit estimates.

Standard errors for the medians and truncated means were estimated by bootstrapping (see chapter II) with 200 replications. Bootstrapping was used because there is no analytic formula for a standard error of the truncated mean. Although an approximate asymptotic formula exists for the standard error for the median, bootstrapping will probably give a more reliable estimate,particularly for small samples.

It can be seen from Table 37 that there is relatively little variation across basins for the resident net economic values for as measured by the truncated mean. There is slightly more variation as measured by the median, but the values are still relatively stable. There is not a large difference between rivers and reservoirs. For nonresidents there is a much larger difference between rivers and reservoirs. In addition, the median nonresident value per trip is much higher than for residents.

Calculation of Total Net Economic Values

Having the net economic value estimates for the seven models it is now possible to combine these with the total recreational use days from chapter III in order to arrive at total net economic value figures for the Missouri Basin waters. The truncated means were used in all these calculations. This means that the resulting estimates of total economic value can be viewed as conservative estimates of the true total or as estimates of the total after limiting the contribution of any individual. Table 38 shows the net economic value per day statistics for the 8 logit models and Table 39 presents the products of the total use and average value per day tables. Also shown are the standard errors associated with these estimates.

Table 35

Estimated Bivariate Equations
Current Trip Regression

Model	Intercept (Std.Err.)	log(BID) (Std.Err.)	P**
Residents			
Upper Subbasin			
Rivers	3.455 (.529)	-.845 (.112)	.610
Reservoirs	2.907 (.367)	-.745 (.079)	.25
Middle Subbasin			
Rivers	3.704 (1.14)	-.835 (.243)	.727
Reservoirs	2.822 (.431)	-.747 (.094)	.549
Lower Subbasin			
Rivers	4.137 (.779)	-.988 (.171)	.89
Reservoirs	3.171 (.749)	-.754 (.158)	.006
Nonresidents			
Rivers	6.841 (1.43)	-1.099 (.221)	.093
Reservoirs	4.338 (1.23)	-.836 (.213)	.49

** If $P > .05$ we accept the null hypothesis that the estimated model fits the hypothetical logistic model.

Table 36

Estimated Multivariate Equations
Current Trip Estimation

Model	Const.	ln(BID)	ln(INCOME)	ln(TRIPL)	CLUB
Residents					
Upper Subbasin					
Rivers N=336	-3.418 (2.08)	-0.944 (.129)	.672 (.21)	.936 (.20)	--
Reservoirs	(insufficient sample size to estimate)				
Middle Subbasin					
Rivers N=77	3.884 (1.24)	-1.071 (.284)	--	1.176 (.449)	--
Reservoirs N=404	-1.659 (1.86)	-0.806 (.104)	.428 (.18)	.524 (.18)	--
Lower Subbasin					
Rivers N=155	3.739 (.802)	-1.016 (.179)	--	.878 (.32)	--
Reservoirs N=174	-2.399 (2.82)	-0.820 (.178)	.5289 (.278)	.758 (.258)	--
Nonresidents					
Rivers N=143	-0.6202 (3.79)	-1.224 (.256)	.766 (.77)	--	--
Reservoirs N=69	4.758 (1.41)	-0.990 (.256)	--	--	1.647 (.738)

Note: Numbers in parentheses are standard errors of the estimates.

Table 37

Average Net Economic Values Per Trip Calculated From Bivariate Logit Models in Table 31

Model	TRUNCATED MEAN* (Std. ERROR)	MEDIAN (Std. ERROR)
Residents		
Upper Subbasin		
Rivers	$ 146.55 (13.55)	$ 59.58 (9.72)
Reservoirs **	$ 143.23 (9.46)	$ 49.48 (6.83)
Middle Subbasin		
Rivers	$ 175.19 (27.45)	$ 84.58 (26.42)
Reservoirs	$ 134.62 (10.30)	$ 43.62 (7.49)
Lower Subbasin		
Rivers	$ 142.65 (18.88)	$ 65.92 (12.95)
Reservoirs	$ 163.78 (19.56)	$ 67.03 (16.66)
Nonresidents		
Rivers	$ 792.52 (85.39)	$ 506.19 (103.98)
Reservoirs	$ 507.14 (111.59)	$ 178.89 (69.25)

---

* Truncation point is $500 for residents and $ 2000 for nonresidents.

** Upper subbasin reservoir estimates for residents are the pooled estimates for all resident reservoir use. This was done due to an insufficient sample size for more disaggregated estimation.

Table 38

Average Net Economic Values Per Day
Current Trip Question

Model	Based on Truncated Mean*	Std. Err.
Residents		
Upper Subbasin		
Rivers	$ 52.53	$ 9.77
Reservoirs **	$ 39.90	$ 10.23
Middle Subbasin		
Rivers	$ 60.20	$ 14.15
Reservoirs	$ 49.68	$ 5.95
Lower Subbasin		
Rivers	$ 65.73	$ 10.60
Reservoirs	$ 40.24	$ 7.95
Nonresidents		
Rivers	$ 193.30	$ 23.70
Reservoirs	$ 128.72	$ 33.37

---

* Truncation point is $500 for residents, $2000 for nonresidents.

** Upper subbasin reservoir estimates for residents are the pooled estimates for all resident reservoir use. This was done due to an insufficient sample size for more disaggregated estimation.

Table 39

Total Net Economic Value
Current Trip Question

Model	Total Values Based on Truncated Mean	Std. Err.
Residents		
Upper Subbasin		
Rivers	$ 21,734,550	$ 4,408,382
Reservoirs **	$ 3,219,291	$ 1,077,587
Middle Subbasin		
Rivers	$ 24,706,200	$ 6,782,156
Reservoirs	$ 18,206,776	$ 3,151,261
Lower Subbasin		
Rivers	$ 15,698,777	$ 3,554,516
Reservoirs	$ 11,217,745	$ 2,858,727
Resident Total	**$ 94,780,952**	**$ 9,865,598**
Nonresidents		
Rivers	$ 39,983,332	$ 6,534,283
Reservoirs	$ 9,260,117	$ 2,831,912
Nonresident Total	**$ 49,243,449**	**$ 7,121,557**

** Upper subbasin reservoir estimates for residents are the pooled estimates for all resident reservoir use. This was done due to an insufficient sample size for more disaggregated estimation.

Table 40

Total Net Economic Value
95% Confidence Intervals Based on Table 39
Current Trip Question

Model	Total Values Based on Truncated Mean Lower		Upper
Residents			
Upper Subbasin			
Rivers	$ 13,094,121	---	$ 30,374,979
Reservoirs **	$ 1,107,221	---	$ 5,331,362
Middle Subbasin			
Rivers	$ 11,413,174	---	$ 37,999,226
Reservoirs	$ 12,030,304	---	$ 24,383,248
Lower Subbasin			
Rivers	$ 8,731,926	---	$ 22,665,628
Reservoirs	$ 5,614,640	---	$ 16,820,850
Resident Total	**$ 75,444,380**	---	**$ 114,117,522**
Nonresidents			
Rivers	$ 27,176,137	---	$ 52,790,527
Reservoirs	$ 3,709,570	---	$ 14,810,665
Nonresident Total	**$ 35,285,197**	---	**$ 63,201,709**

Comparison to Previous Studies

The estimated net economic values per day provided in Table 38 can be compared to previous estimates of the values associated with river recreation. Walsh, Johnson and McKean (1988) reviewed 120 studies of outdoor recreation demand completed between 1968 and 1988 for various U.S. sites. The mean value they report for coldwater fishing is $30.62 based on 39 estimates with a range of $10 to $118 dollars across studies (1987 dollars). The mean value for nonmotorized boating they report is $48.68 based on 11 estimates and with a range of $10 to $183 per day. A mean value of $20.14 is reported for camping, picnicking and swimming based on 36 estimates with a range of $7 to $47 per day.

The estimates in Table 38 are of course for a combination of river activities. The estimates for residents are close to the mean and well within the reported range for fishing and nonmotorized boating value estimates at other U.S. sites. The nonresident values are at the high end of the reported ranges. It is likely that the Missouri River Basin rivers and reservoirs are on average higher quality than the average U.S. water-based recreation site.

The estimates in Table 34 can also be compared to previous recreation value estimates in Montana. Previous studies have largely addressed the value of fishing. Duffield, Brooks and Loomis (1987) estimated the value per day of lake and reservoir fishing in Montana at $37 to $80 and stream fishing at $55 to $118 per day using a travel cost model (updated to 1989 dollars). Duffield and Allen (1988) used a dichotomous choice CVM model to estimate the value of fishing on 19 of the better trout streams in the state. The estimate was $125 (1989 dollars) per day. These estimates combine both resident and nonresident use. In general the estimates in the current study for all river and reservoir related recreation are similar to previous estimates for angler use only.

Chapter VI

Valuation of Instream Flows

A major goal of this study was the estimation of recreational values for instream flows within the Missouri River Basin. In order to do this it was necessary to examine the role which water levels play in recreational decision making, and the satisfaction people receive from that recreation.

Before asking about trips taken during the summer of 1989, survey respondents were asked a series of questions about trips which they took during the drought summer of 1988. Respondents were presented with a list of specific streams and reservoirs and asked about their 1988 trips to these waters. The questions and results are summarized below.

(1) As you may recall, 1988 was a year of severe drought in Montana. How did the low water levels in 1988 affect the number of trips you took to these areas last year? (Please check one)

	fewer trips	more trips	no change
Residents	51.8%	1.5%	46.7%
Nonresidents	34.3%	0.8%	64.8%

(2) How did low water levels on these rivers or their tributaries affect the overall quality of your trips in 1988?

	quality was raised	quality was unchanged	quality was lowered
Residents	1.1%	34.0%	64.8%
Nonresidents	1.8%	40.1%	57.6%

The responses to these two questions suggest that both the number of recreational trips and the quality of those trips suffer in times of severely low water flows. This chapter details the methodology used and the results obtained in determining the marginal value of instream flows in the Missouri River Basin.

In order to model the sensitivity of water based recreation to flow levels this study used an adaptation of a model used by Narayannan (1986). As was discussed in detail in Chapter II, this model involved asking respondents who had indicated they recreated at a Missouri Basin river or reservoir a hypothetical question regarding how low the water would have to get before they would not visit the site. The presentation of this question was as follows:

> What is the lowest water level at which you would visit this river or reservoir? (please check one)
>
> ___ at the ACTUAL LEVEL I experienced
> ___ at 90 PERCENT of what I experienced
> ___ at 75 PERCENT of what I experienced
> ___ at 50 PERCENT of what I experienced
> ___ at 25 PERCENT of what I experienced
> ___ at 10 PERCENT of what I experienced
> ___ I would visit the area NO MATTER WHAT the water level was.
> ___ Other ________________________________

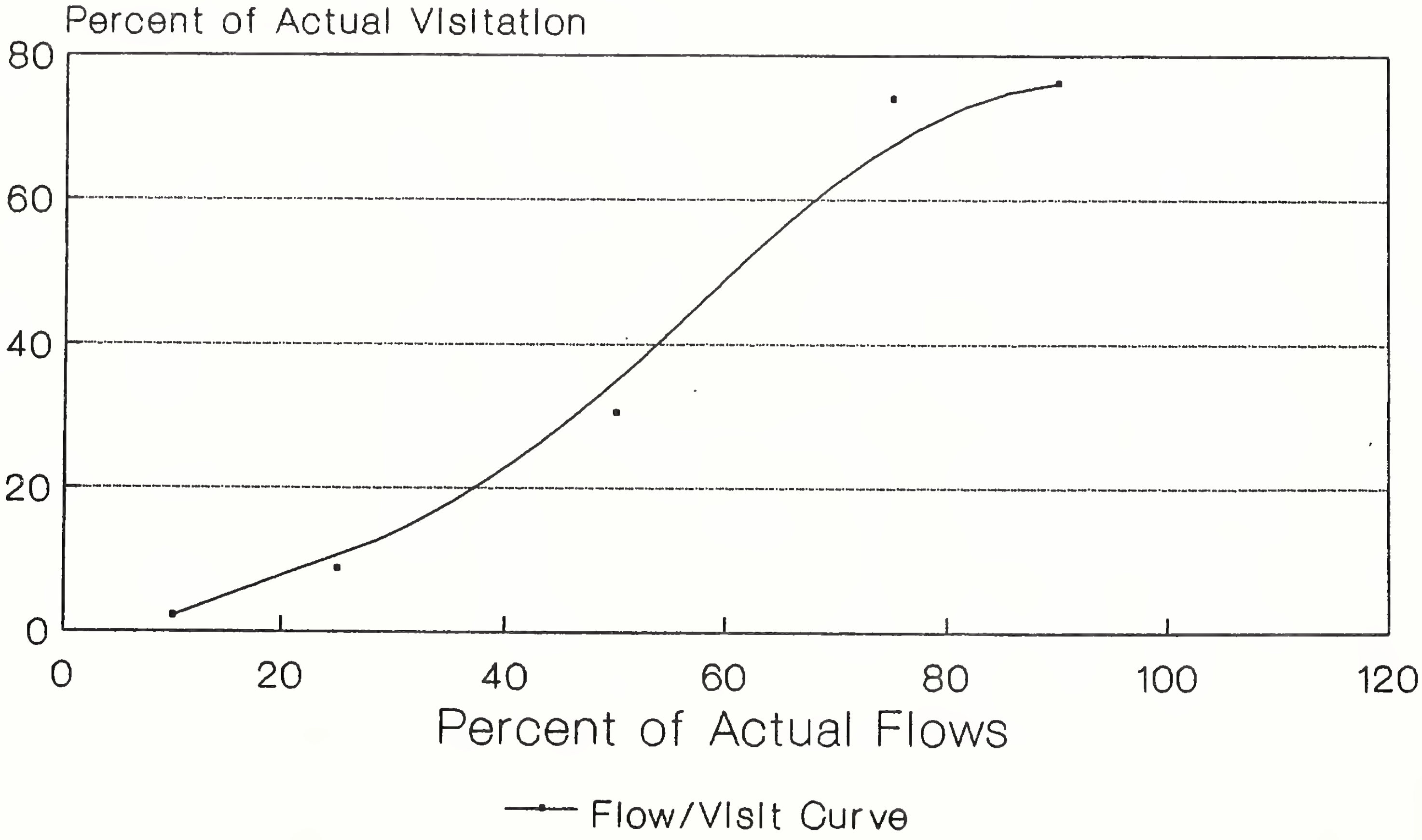
As is discussed in the following section, responses to this question were analyzed in order to determine the relationship of water flow levels to visitation rates.

The Flow / Visitation Model

Before fitting the responses to the flow / visitation question to a model some interpretation of the data was necessary. Three answers in the flow/visitation question capture the responses of those who for one reason or another felt that the 90%, 75%, 50%, 25% and 10% choices did not apply to them. These are the ACTUAL LEVEL, NO MATTER WHAT and OTHER responses. An examination of the frequencies for each of the responses for the entire sample showed that fully 40% of the respondents said they would have made the trip no matter what the water level. Given the other possible flow levels, an interpretation of the NO MATTER WHAT response should include zero water flows as a possible level. However, it was not clear what flow level was being considered with this response since a relatively equal proportion of anglers, boaters, and shoreline users chose this response, (it seems obvious they were not realistically considering zero flows as a possible level.) Probably the majority of these responses are individuals who were not able to answer a specific flow level. Given the difficulty in interpreting these NO MATTER WHAT responses, they were dropped from the sample before further analysis was begun.

Just as there was difficulty in interpreting the NO MATTER WHAT flow level responses, it was also not entirely clear what was intended by those marking "at the ACTUAL LEVEL I experienced" in response to the question. Without making use of the "other" response there was no way for people who went on the trip and found the water unacceptably low to say that with this new information they would NOT EVEN make the trip again at the actual

Figure 2
Visitation vs. Instream Flows



Lower Subbasin Rivers

flow. Since the possibility existed that the number of responses to this top category was being artificially inflated, these responses were also dropped from the following analysis. These responses accounted for 12.8% of the sample.

Finally, 2.6% of the respondents marked other when answering this question. No attempt was made to code these responses to other percentage levels, and thus they were also dropped from the analysis.

A plot of visitation to hypothetical flow levels is shown in Figure 2. The sigmoid shape of this relationship with increasing rates initially and decreasing rates at higher flow levels suggested that two functional forms might provide a good fit to the data. A cubic function of the form shown in equation 19) and a logistic function shown in equation 20) were the possible choices.

19) $P = B_1\ FLOW + B_2\ FLOW^2 + B_3\ FLOW^3$

20) $Ln\ [P/1-P] = B_1 + B_2\ FLOW$

Where:
P = percentage of actual Visitation
FLOW = percentage of actual flows

Because of the limited number of data points in the model to be estimated, the logistic form of equation 20) was chosen to conserve degrees of freedom. As was mentioned in Chapter II, this logistic model was estimated using Ordinary Least Squares regression.

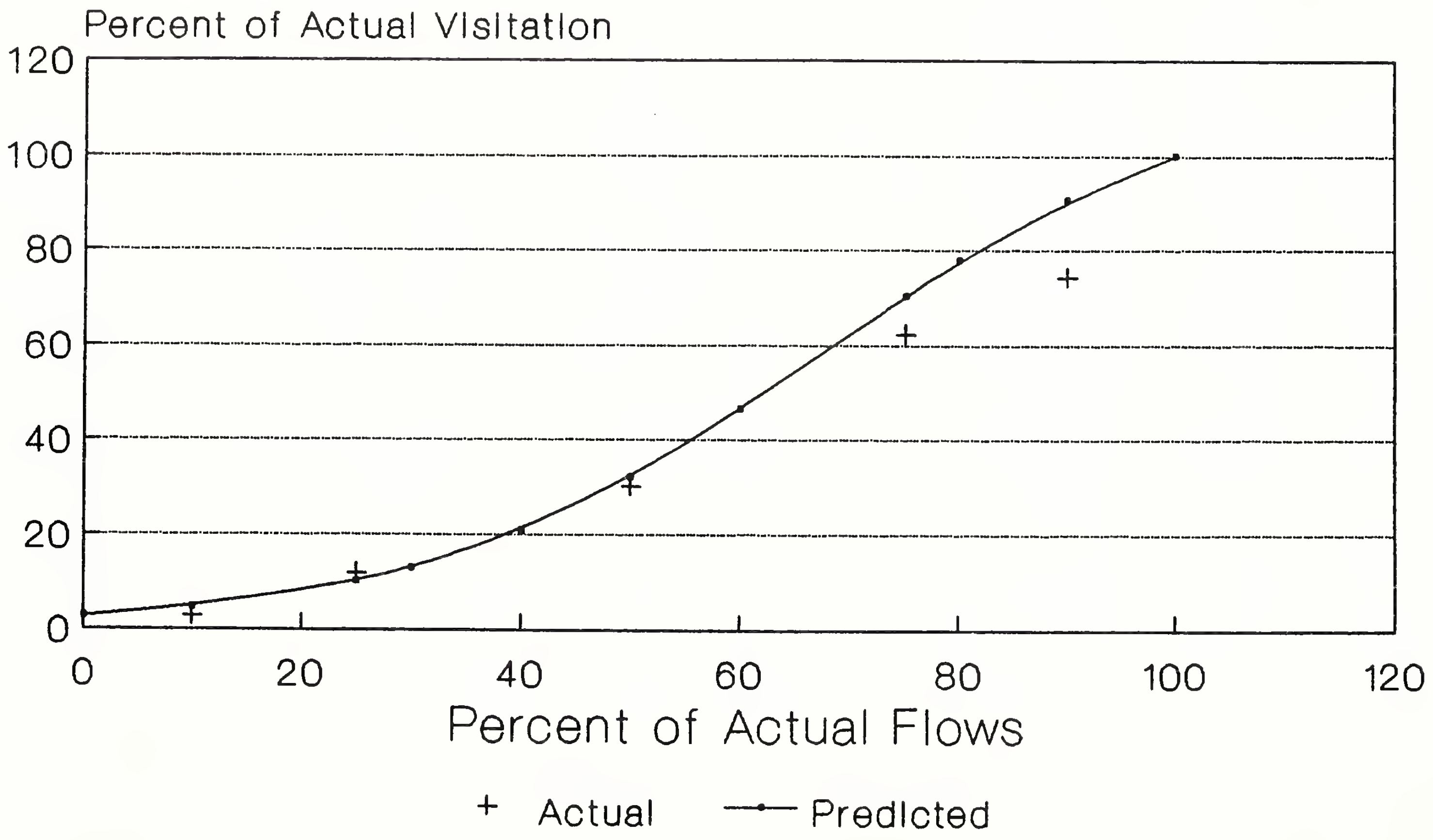
Estimated Equations

Several aggregation levels were chosen for the model estimation. Twelve models of resident use (11 successful) were constructed. These models broke resident use down by water type (river or reservoir), Missouri River Subbasin, and time of year. Regarding time of year, July and August use was modeled separately from the remaining years use for reasons outlined in Chapter II. Two generic models of nonresident use were estimated for all rivers in the basin. These models were for July and August use and the remainder of the year's use. These 13 estimated equations are shown in Table 36.

An examination of the coefficients presented in Table 36 shows them to be both well fitting and very stable across models. The R square statistics which range upwards from .90 show the models to match the data closely, and the high T-statistics on the coefficients suggest good predictive powers for the models.
A plot of actual visitation response rates to predicted rates is shown in Figure 3. It can be seen that the predicted model for this upper subbasin river sample fits the actual responses quite well.

Figure 3

Predicted vs. Actual Resident Responses



Upper subbasin Rivers, July and August

Table 41

Estimated Flow / Visitation Equations

Model	Intercept (Std.Err)	Flow (Std.Err)	R^2
Residents			
Upper Subbasin Rivers			
July and August	-3.7493 (.2894)	.05567 (.0049)	.968
Rest of Year	-4.0741 (.2572)	.06546 (.0044)	.986
Upper Subbasin Reservoirs			
July and August	insufficient data to estimate		
Rest of Year	-4.4807 (.3542)	.05826 (.0048)	.986
Middle Subbasin Rivers			
July and August	-3.5887 (.2028)	.05957 (.0034)	.986
Rest of Year	-4.2184 (.2735)	.05736 (.0042)	.984
Middle Subbasin Reservoirs			
July and August	-3.9426 (.1493)	.05952 (.0025)	.992
Rest of Year	-4.9303 (.3254)	.06810 (.0055)	.973
Lower Subbasin Rivers			
July and August	-3.2104 (.0946)	.04919 (.0016)	.995
Rest of Year	-4.1412 (.3563)	.06368 (.0061)	.964
Lower Subbasin Reservoirs			
July and August	-3.4558 (.2475)	.05291 (.0043)	.974
Rest of Year	-4.0557 (.1749)	.05977 (.0030)	.990
Nonresidents			
Rivers July and August	-4.2639 (.1679)	.05956 (.0026)	.994
Rivers Rest of Year	-5.0289 (.3162)	.07255 (.0054)	.978

Calculation of Marginal Flow Values

Having estimated the flow / visitation equations it was then possible to calculate the marginal values per acre foot of water for each of the estimated models. It was hypothesized that this marginal value would be quite low near zero and would increase to some maximum point and then decrease as flows approached 100%. These a priori expectations were born out by the results of the marginal value calculations. Figure 4 shows a plot of the per acre foot marginal values for upper subbasin resident use of rivers during July and August. It would be expected that the marginal value shown in Figure 4 would continue to decline as flows rise above 100% and would indeed become negative at some point of high flows. The fact that 1989 was a below average flow year and that the questionnaire was not designed to measure decreased participation at flows above 100% of actual flows precluded the observation of these negative marginal values.

The calculation of the marginal values of flows began with the estimated flow/visitation equations. As was shown in Chapter II, the logistic specification of equation 21) can be rewritten as equation 22). The derivative of this equation with respect to FLOW can be calculated through equation 23). Once this derivative has been calculated the marginal value of flows can be found through the straightforward application of equation 24)

21) $$\log[P/1-P] = B_1 + B_2\,\text{FLOW}$$

22) $$P = (\;1\;/1 + \exp -(B_1 + B_2\,\text{FLOW}))$$

23) $$\frac{dP}{dF} = \frac{B_2 * \exp -(B_1 + B_2\,\text{FLOW})}{(1+ \exp -(B_1 + B_2\,\text{FLOW}))^2}$$

24) $$\text{Marginal Value} = \frac{dP/dF * \text{Total Value}}{\text{Total Discharge}/100}$$

In order to estimate the marginal values for July and August and for the rest of the year the numerator of equation 24 was multiplied by the percentage of total year angler use which occurred on a 19 river sample of Montana waters in 1985 (Neher, 1989) during the months being estimated.

The final element necessary for equation 24 was total discharge. Total discharge should correspond to instream flows at the point where the recreational use reflected in the total value term occurs. Since recreation use in this application is over fairly large subbasin areas, it is necessary to use average instream flows through these same areas. The calculation of total discharge was constrained by two factors: (1) measurement of flow could only be determined for locations which had a U.S. Geological Service gauging station and (2) The flow of water within rivers and streams is not a closed system (there are irrigation withdrawals and ground water charges and discharges) thus a measurement of flow at the mouth of a river will not necessarily equal the sum of flows of all rivers and streams entering that river.

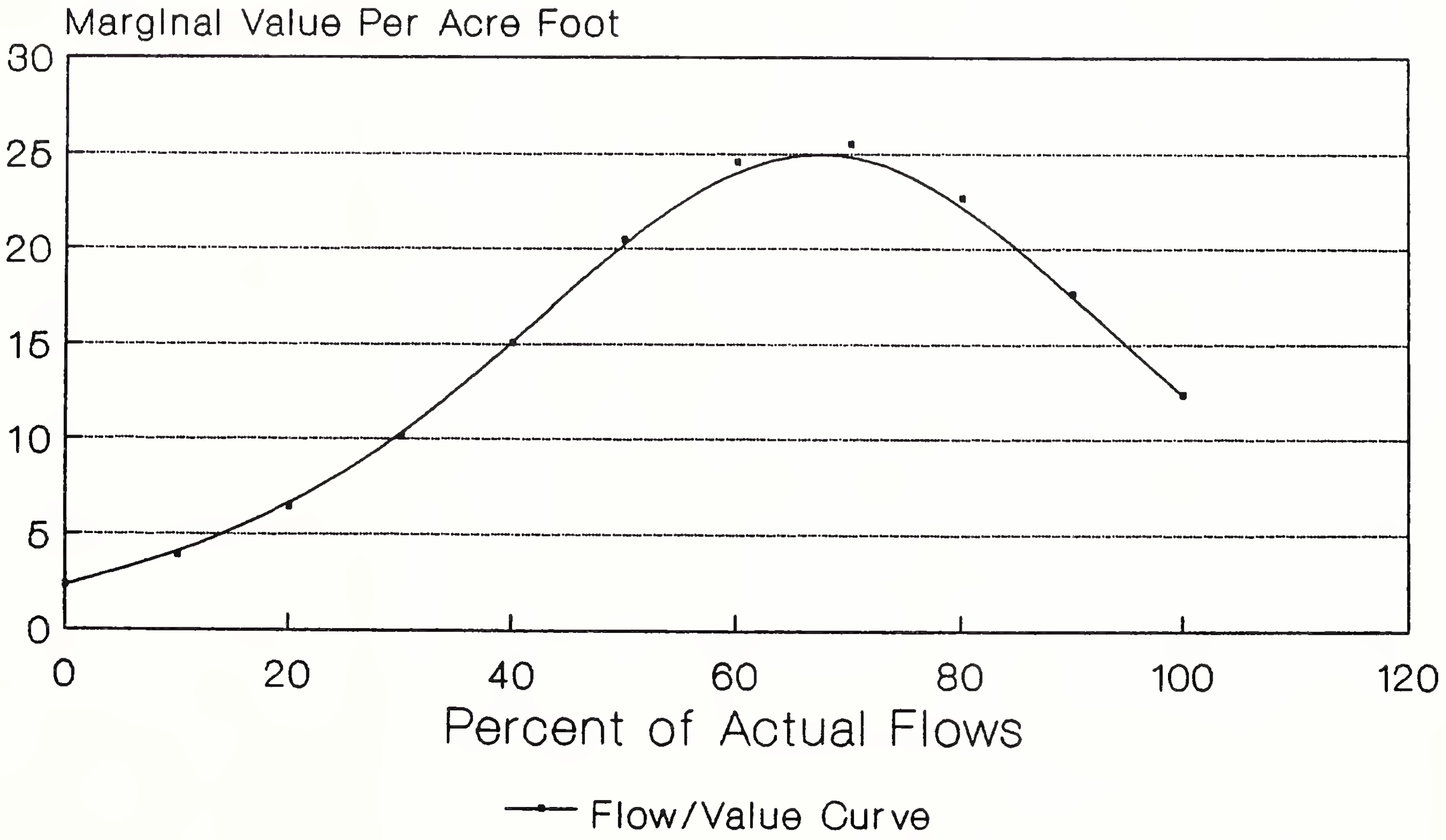
Where possible, water gauge readings from all major component streams within a subbasin were summed in order to arrive at total discharge. This is a conservative method which accounts for more flow than would be measured by a gauge at the bottom of the subbasin. A dramatic example of this comes from the Upper Missouri Subbasin. Records from the Toston gauge (several miles downstream from the lower boundary for the Upper Subbasin) show a combined July and August discharge of 230,700 acre feet. If, however, the discharge readings from upstream guages on the Missouri's major tributaries (Big Hole, Jefferson, Madison, Gallatin, Beaverhead, Boulder, Ruby, and Red Rock) are summed the resulting July-August discharge is 432,130 acre feet. It was this larger figure which was used in the following analysis, thus diluting the weight (and value) given to each acre foot.

The total discharge for reservoirs was a stock variable rather than a flow. Thus the month end contents of the reservoirs were used to calculate a per month marginal value.

Tables 42 through 45 show the marginal flow values calculated for the resident and nonresident models. The tables for river use report marginal values per acre foot for the entire time period being examined. The table for reservoirs, however, reports per month marginal values for the time period being examined.

Figure 4

Marginal Instream Flow Valuation



Upper Sub,Residents,Rivers,July and Aug

Table 42

Marginal Values Per Acre Foot of Flow
Rivers and Streams
Resident Use

	July and August			Rest of Year		
Model	50% (SE)	75% (SE)	100% (SE)	50% (SE)	75% (SE)	100% (SE)
Upper Subbasin	20.44	24.46	12.31	7.71	7.61	2.59
	(4.14)	(4.96)	(2.49)	(1.56)	(1.54)	(.52)
Middle Subbasin	25.62	23.28	8.79	4.82	7.37	4.35
	(7.03)	(6.39)	(2.41)	(1.32)	(2.02)	(1.19)
Lower Subbasin	8.49	9.21	5.06	3.25	3.67	1.43
	(1.92)	(2.08)	(1.14)	(.74)	(.83)	(.32)

Table 43

Marginal Values Per Acre Foot of Flow
Rivers and Streams
Nonresident Subsample

	July and August			Rest of Year		
Model	50% (SE)	75% (SE)	100% (SE)	50% (SE)	75% (SE)	100% (SE)
Upper Subbasin	29.84	43.52	23.09	10.17	15.37	5.64
	(4.87)	(7.11)	(3.77)	(1.66)	(2.51)	(.92)
Middle Subbasin	2.43	3.55	1.88	.76	1.14	.41
	(.40)	(.58)	(.30)	(.12)	(.19)	(.07)
Lower Subbasin	.97	1.42	.75	.35	.54	.20
	(.16)	(.23)	(.12)	(.06)	(.09)	(.03)

Table 44

Marginal Values Per Acre Foot of Flow
Rivers and Streams
Total For Resident and Nonresident Use

	July and August			Rest of Year		
Model	50% (SE)	75% (SE)	100% (SE)	50% (SE)	75% (SE)	100% (SE)
Upper Subbasin	50.28	67.98	35.40	17.88	22.98	8.23
	(6.39)	(8.67)	(4.52)	(2.28)	(2.94)	(1.05)
Middle Subbasin	28.05	26.83	19.46	5.58	8.50	4.76
	(7.04)	(6.41)	(2.43)	(1.33)	(2.03)	(1.19)
Lower Subbasin	9.46	10.63	5.81	3.60	4.21	1.63
	(1.92)	(2.09)	(1.15)	(.74)	(.83)	(.32)

Table 45

Per Month Marginal Values Per Acre Foot of Flow
Reservoirs[*]
Resident Subsample

	July and August			Rest of Year		
Model	50% (SE)	75% (SE)	100% (SE)	50% (SE)	75% (SE)	100% (SE)
Upper Subbasin	Unable to estimate			.65	1.14	.75
				(.69)	(1.21)	(.79)
Middle Subbasin	1.20	1.41	.62	.36	.62	.29
	(.29)	(.34)	(.15)	(.20)	(.34)	(.15)
Lower Subbasin	.05	.06	.03	.02	.02	.01
	(.02)	(.02)	(.01)	(.02)	(.02)	(.01)

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[*] The subbasin level reservoir models have been estimated using one representative reservoir from each subbasin. Clark Canyon Reservoir was used for the Upper subbasin, Canyon Ferry for the Middle, and Fort Peck for the Lower subbasin.

The standard errors for the marginal values in Tables 42 through 45 are a direct product of the standard errors of the total value figures for the subbasins. Since the calculation of a standard error on the derivative of the flow/visitation equations is very problematic this value was treated as a constant, as was the observed flow for the year. The resulting standard error calculation is discussed in Appendix B. These estimated standard errors should be considered rough estimates of the actual ones, and caution should be exercised in their use or interpretation. Complete tables of marginal values and estimated standard errors for all flows from 0% to 100% can be found in Appendix D.

An examination of the marginal values presented in Tables 42 through 45 shows several expected results. The values for the July and August subsamples are higher than for the rest of the year. This makes intuitive sense in that much of the use occurs in these two months and flows are generally low. It is also interesting to note that nonresident angler flow values are much higher for the Upper Missouri Subbasin than for the middle and lower subbasins. This is not entirely unexpected given the widespread reputation of rivers such as the Madison and the Bighole as well as many other productive trout waters in this subbasin.

Calculation of Average Flow Values

An alternative approach to estimating the value per acre foot of flows is to compute the average value per acre foot. The average value is simply total value divided by total discharge and does not require the use of the flow/visitation model. Of course this approach to valuing instream flows obscures any differences in value at different flow levels. Table 46 presents average acre foot values for the same aggregations of resident and nonresident use as in Tables 42 to 45. The values in Table 46 are generally lower than the reported marginal values at flow levels of 50 percent or 75 percent of current flows, but greater than the marginal value at current (100 percent) flows.

Limitations of the Flow Analysis

The marginal flow values derived here are estimates of value and as such are subject to the limitations of the analysis used in this study. These limitations can be discussed best in relation to the four component parts of the marginal value equation: the flow/visitation relationship, the net economic trip values, the observed shares of total use assigned to times of the year and the total discharge.

Perhaps the most serious limitation of this analysis lies in the survey methodology used. Both the scope and budget of this study dictated the use of a mail survey. The data, therefore, is based on contingent behavior rather than observed behavior. This contingent behavior is subject to difficulty in interpretation. Questions arise as to whether the respondents accurately describe their actual flow/visitation participation patterns, whether they understand the flow/visitation question as asked, and whether they understand how 10,25 or even 50% of current flows translates into the levels of water which they fish in, swim in, or boat on. One manifestation of the problems in using contingent behavior instead of observed behavior can be seen in the difficulty in interpreting the responses of people saying they would visit a site at any flow level or those responding they would only visit at the current flow level. Data based on observed behavior would show an actual observed flow level and an observed visitation level. No interpretation of responses would be necessary.

In defense of this aspect of the study, the marginal values derived here are consistent with values derived from studies based on observed behavior. This consistency, which is discussed more fully below, lends a degree of validation to the results of the current study.

The second component of the marginal value equation is the total net economic value of water based recreation for the subbasins. These estimates of total recreational value have been derived using established methodologies and are consistent with values estimated by other Montana recreational studies (see discussion in Chapter V).

The observed percentage of total use allocated to different times of the year has the potential to bias the distribution of value between the July-August period and the rest of the year. This percentage is based on only one data base (DFWP 1985 fishing pressure estimates). While this is a high quality data base it should be remembered that it is also highly aggregated and thus could mask local or regional differences in visitation patterns.

Finally, total discharge has an affect on the magnitude of the estimated marginal values. As was discussed previously, the extent of the areas for which values are calculated makes determination of the correct flow figure to use difficult. It would be easiest to have one point on a river where recreation takes place and to measure the flows at that point. The extension of this simple case to the current one where recreation on hundreds of miles of rivers and streams is considered make determination of the proper measure of stream flow difficult. This analysis was constrained by the available data on flows as collected by the U.S.Geological Service. While every effort was made to use flow data which would be representative of the areas where most water based recreation took place the limitations of the available flow data and uncertainty as to the exact distribution of recreation within a subbasin introduced possible sources of error into the calculations of total discharge.

Table 46

Average Values Per Acre Foot of Flow

Model	July and August	Rest of Year
Rivers		
Residents		
Upper Subbasin	18.39	5.51
Middle Subbasin	18.85	5.14
Lower Subbasin	7.92	2.55
Nonresidents		
Upper Subbasin	29.55	8.85
Middle Subbasin	2.41	.66
Lower Subbasin	.97	.31
Total		
Upper Subbasin	47.94	14.36
Middle Subbasin	21.26	5.80
Lower Subbasin	8.89	2.86
Reservoirs		
Upper Subbasin	----	7.87
Middle Subbasin	1.01	.37
Lower Subbasin	.048	.016

Note: The subbasin level reservoir models have been estimated using one representative reservoir from each subbasin. Clark Canyon Reservoir was used for the Upper subbasin, Canyon Ferry for the Middle, and Fort Peck for the Lower subbasin.

Comparison to Previous Flow Valuation Studies

Previous research on instream flow valuation was described in Chapter II. In order to compare values across studies, it is useful to recognize that the total value of recreation at a given site as a function of flow is given by:

$$TV(F) = U(F)\ W(F)$$

or the total recreational value (TV) is equal to total use (U(F) given in days or trips) times the value of a given recreation day or trip (W(F)). The marginal value of a change in flow is then the total derivative of this expression, or:

$$dTV/dF = dU/dF\ W + dW/dF\ U = MV(F)$$

Letting Eu,f equal the elasticity of total use with respect to flow and Ew,f be the elasticity of unit value with respect to flow, the second expression can be rewritten as:

$$MV(F) = (U\ W/F)\ (Eu,f + Ew,f)$$

This is an interesting result in that it shows that marginal value is simply the average value of flows (the first term in this third equation) times the dimensionless elasticity sum. Certainly the difficult aspect of instream flow valuation is identifying the relationship of flow and either use or value as summarized by the elasticity term. However, even if sites have identical use-flow or value-flow elasticities, there may be considerable differences across sites due to differences in either use, value per day (or trip) and flow levels. Because of this, one needs to be cautious in comparing values across site.

A case in point is comparing Narayanan's (1986) study of the Blacksmith Fork River in Utah with the current study. Although the same basic methodology was used, Narayanan's estimate of the marginal value of an acre foot of water varies from around 1 cent to about 85 cents. This is in 1982 dollars and would be about 2 cents to a $1.10 in 1989 dollars. This contrasts with estimates of from $3 to $48 dollars for streams in the Upper Missouri Basin. The differences are not due particularly to the complex elasticity term, but simply because of differences in the relative total value and total flows in these rivers.

Taking the specific example of the Big Hole to compare to the Blacksmith Fork, use on the Blacksmith Fork was estimated at 1716 trips for July-September in a normal year. This contrasts with 15,419 trips estimated to the Big Hole in 1989 for just July and August. Blacksmith Fork trips were valued at only $4.70 per trip in 1982 dollars (or $6.06 in 1989 dollars) compared to this study's estimate of $170.71 for trips to the Big Hole in our survey year (1989). These considerable differences lead to total benefit estimates of $10,399 for the summer on the Blacksmith Fork (1989 dollars) compared to our estimate of $2.63 million for the Big Hole. While the summer flows on the Big Hole in 1989 were over four times the flows in a normal water year on the Blacksmith Fork (463 cfs and 105 cfs respectively), this still leads to great differences in average flow values because of the great difference in estimated total recreation benefits. The average value of an acre-foot on the Blacksmith Fork is 54 cents (1989 dollars) compared to $46.35 on the Big Hole. An examination of the travel cost model data base for the Blacksmith Fork seems to indicate that it primarily attracts visitors from the near vicinity (and not many of those). This contrasts with the Big Hole which is a major destination fishery for anglers from all over the United States.

The point of this simple example is that as one would expect, the marginal value of flows is closely tied to the overall value of a given recreational resource. One should therefore be cautious in attempting to compare (or extrapolate) instream flow values from one site to another without at least correcting for differences in total use, value per trip (or day) and relative average flows. The range in values across sites in the reported literature is, as one would expect, fairly large. One of the first studies, by Daubert and Young (1981) estimated marginal values for the Cache La Poudre river near Fort Collins. The values ranged from $12 per acre foot (1978 dollars) at 100 cfs to near zero at 500 cfs for May to October and from $20 per acre foot at 100 cfs to zero around 500 cfs for July and August. Correcting these values for inflation, their July-August estimate is $38.14 in 1989 dollars at 100 cfs.

A study of the value of flows in the Grand Canyon (Bishop et al 1989) does not report an acre foot value. However, an average value can be derived from the reported data for the 1984 water year of about 56 cents per acre foot. An approximate marginal value for an increase of flows from 5000 to 13000 cfs may be on the order of 70 cents. Although the Grand Canyon trip values were comparatively high (ranging from about $100 to $900 per trip for different flow levels), and total benefits were large ($11.6 million), so is the total annual flow in the Colorado (on the order of 20.8 million acre feet in 1984). Marginal values are also low because they only reflect changing trip values (since total use is constrained by a permit/quota system that is not sensitive to flow levels).

A more appropriate comparison is to examine the results of different instream flow valuation methods applied to the same site. Neher (1989), Duffield, Butkay and Allen (1990) and the current study can all be used to derive estimates for the Big Hole river. This comparison is somewhat complex in that these studies use very different methods and sampled different time periods, activities and river sections.

A flow-value relationship specific to the Big Hole was estimated in the current study. A Big Hole specific average trip value was also estimated (pooling resident and nonresident responses) for a mean truncated at $500 of $170.71. Based on previously described use estimates, this yields marginal values at 1989 average flow levels of $18 and $3 for July-August and Sept-June respectively. When flows are at 25 percent below 1989 levels, these marginal values increase to $43 and $9 respectively.

Neher (1989) used a pooled time series-cross sectional sample of angler use on 19 Montana rivers for 1982, 1983 and 1985 to construct a zonal travel cost model that included annual average flow as an independent variable. Flow was found to be a significant explanatory variable in several specifications. Because he used a double-log model, the elasticity of use with respect to flow is constant and can be easily derived. For the entire 19 river sample the elasticity is +.352 and a sample average value per acre foot is $1.03. Because the model is estimated on annual data, this estimate of $1.03 is likely to be lower than a summer (July-August) estimate and higher than a "rest of the year" estimate, other things equal. The average value per acre foot for all 19 rivers was $2.83. The marginal value of $1.03 is probably appropriate only for small changes from normal flows (which may not have significant impacts on use and benefits). This is because the sample of 19 rivers included a number of dam-controlled rivers that did not show considerable variation over the sample years.

Neher estimated a separate model for his subsample of 8 free flowing rivers including the Big Hole. The elasticity for this model is +.826. Using this parameter with Neher's estimated angler recreation benefits on the Big Hole in 1985 ($11.4 million) and 1985 flows (795 cfs average) yields an estimated marginal value of $16.35. The related average value per acre foot is $19.80. These estimates are conservative in that they exclude non-angler recreation use. If these estimates are inflated by the .546 angler share found in the current study, an estimated marginal value per acre foot for the Big Hole is $30. This estimate falls in the range of values estimated in the current study.

A very different approach to modeling the value of instream flows was taken by Duffield, Butkay and Allen (1990). These authors used an on-site survey in the summer of 1988 to estimate the relationship of observed use and U.S. Geological Survey reported daily flows for the period May to August. Their study is indexed on average flows at the permanent Melrose gauge and a temporary gauge at Wise River. At 200 cfs for the gauge averages, they estimate a marginal value of $12 per acre foot and at 400 cfs, $9. These estimates are only for their study section of Wise River to Glenn, which accounts for only about 43 percent of total

Big Hole use. Inflating their estimate to correspond to a Big Hole mainstem estimate yields values of $21 to $28. These estimates are also within the range of those provided by the current study.

To conclude, There is remarkable similarity in estimates of instream flow values for the Big Hole from these different studies. This provides a measure of validation for the current study estimates.

Chapter VII

Instream Flow Trust Fund Valuation

The benefits of instream flows extend beyond the provision of habitat for fish, wildlife and increasing numbers of recreation visitors. Keeping adequate amounts of water in rivers and streams also has intrinsic or indirect values to many people. For example, individuals may value simply knowing that there is a large and dramatic river flowing through the Grand Canyon, even if they hadn't seen it themselves. They also may benefit from knowing that they can see the river in the future, or from preserving this opportunity for future generations.

Trust Fund Format

In order to determine the magnitude of the intrinsic values which people place on the preservation of instream flows in the Missouri River Basin a second CVM question was asked of respondents regarding their willingness to support efforts to protect these flows. The actual dichotomous choice CVM trust fund question was preceded by two questions on the respondents familiarity with existing trust fund efforts. Two paragraphs briefly detailing the problem of dewatering in the Missouri Basin and how a trust fund could mitigate the damages directly preceded the CVM question as follows:

> As you may be aware, sections of some Missouri Basin rivers such as the Big Hole, Gallatin, Smith, Sun, Judith and Musselshell typically have had low summertime flows. Low flows can occur in other basin streams, especially in drought years. Often existing flows in streams are not legally protected and could be reduced by new diversions of water.
>
> To help protect existing flows, a private trust fund could be established to purchase or lease water to maintain fish, birds, wildlife and plants, and recreational uses. This would benefit people who use these rivers for recreation as well as those who believe having water in rivers is important. The effectiveness of the trust fund would increase with the amount of money contributed to it.
>
> If you were contacted within the next month, would you pledge to make an annual contribution of $__X__ to help buy the water to maintain summertime flows on Missouri Basin streams?

As with the current trip CVM question the respondents were asked to answer yes or no to this question. The values placed in the trust fund questions ranged from \$5 to \$200 for Montana residents and from \$5 to \$500 for nonresident anglers. A complete discussion of the determination of these bid ranges and their distributions can be found in Appendix C; "Bid Distribution Analysis: DNRC Missouri River Basin Recreational Survey" (Duffield, Patterson and Butkay, 1989).

The answers to the trust fund question were screened in order to eliminate protest responses using the same criteria used for the current trip question.

Functional Form

Since the same question was asked of all respondents, sample sizes were sufficient to allow analysis of the responses in a stratified manner. Therefore, there were five models estimated, one for each of the five sample strata: lower subbasin residents, middle subbasin residents, upper subbasin residents, out-of-basin residents and nonresident anglers. The following multivariate logit model was used.

$$25)\quad \log[P/1-P] = b_0 + b_1 \log(BID) + b_2 \log(INCOME) + b_3 (CLUB) + b_4 (PARTIC) + b_5 (MEMBER)$$

Where:

P = Probability of a yes response
BID = Trust fund contribution amount asked.
INCOME = Annual household income
CLUB = Dummy variable for membership in a sportsman's organization: 1=belongs to one, 0=doesn't belong.
PARTIC = Dummy variable for participation in water-based recreation: 1=participates, 0=doesn't participate.
MEMBER = Dummy variable indicating whether respondent has ever donated to a trust fund before: 1=yes, 0=no.

Estimated Equations

The five estimated trust fund equations are shown in Table 47. The independent variables in these equations are all significant at the .05 level except for one which is significant at the .10 level. As was done with the current trip models, bivariate forms of the trust fund models were estimated. Since these bivariate models provided good fits to the data they were used in the calculation of the truncated means and medians. The estimated bivariate trust fund equations are shown in Table 48.

Table 47

Estimated Logistic Regression Models
Trust Fund Question

Model	Constant	BID	INCOME	CLUB	MEMBER	PARTIC
Lower Sub. Residents N=670	-3.527 (1.849)	-1.222 (.131)	0.566 (.183)	0.912 (.311)	--	--
Middle Sub. Residents N=649	-8.608 (2.033)	-1.340 (.135)	1.030 (.198)	--	1.060 (.272)	0.958 (.473)
Upper Sub. Residents N=615	-5.337 (1.917)	-1.006 (.121)	0.670 (.192)	1.162 (.303)	0.968 (.283)	--
Out-Of-Basin Residents N=608	-6.449 (2.432)	-1.130 (.153)	0.751 (.239)	0.684 (.409)	1.044 (.382)	--
Nonresident Anglers N=431	-7.964 (2.981)	-0.855 (.116)	0.888 (.281)	--	--	--

Note: Number in parentheses are standard errors of the parameter estimates.

Table 48

Estimated Bivariate Logistic Regression Models
Trust Fund Question

Model	Constant (Std.Err)	log(BID) (Std.Err)	P
Lower Subbasin Residents	2.091 (.356)	-1.176 (.118)	.436
Middle Subbasin Residents	2.519 (.358)	-1.181 (.112)	.321
Upper Subbasin Residents	1.571 (.338)	-.847 (.099)	.986
Out-Of-Basin Residents	1.342 (.386)	-1.008 (.125)	.327
Nonresident Anglers	1.358 (.412)	-.836 (.111)	.428

** If P > .05 we accept the null hypothesis that the estimated model fits the hypothetical logistic model._

Trust Fund Benefit Estimates

As with the analysis of the current trip responses, two measures of net willingness to pay for an instream flow trust fund were calculated. These measures were the median and the truncated mean willingness to pay. These welfare measures for the five strata as well as the entire aggregated sample are presented in Table 49. Once again the upper limit of integration for the truncated mean was the maximum bid level: $200 for residents and $500 for nonresidents. The truncated mean annual net economic value of the trust fund ranges from $14.92 among out-of-basin Montana residents to $33.07 for nonresident anglers.

Table 50 presents the calculation of the total value based on truncated means of a Missouri River Basin trust fund for both residents and nonresident anglers. The estimate for the annual value of the trust fund for residents is $ 9,995,598. The nonresident angler estimated value is $ 3,555,422 per year for a total value of $ 13,551,020. The latter estimate may be conservative in that other nonresidents who recreate on or care about Montana rivers were not sampled.

Using the bootstrapping methodology employed for the current trip estimates, standard errors were estimated for the trust fund benefit estimates. These standard errors for both the individual model estimates and the aggregate value figures are presented in Table 51. The aggregate trust fund estimate is relatively precise with a 90 percent confidence interval that is only plus or minus 10 percent of the estimate.

It should be noted that the aggregate estimate of 13.5 million per year is based on the assumption that respondents and nonrespondents are identical with respect to river valuation. An alternative assumption is that nonrespondents have zero indirect values. In this case, the trust fund values are the respective response rates (50.5% for nonresidents, etc.) times the values presented in Table 50. It was not possible to address this issue in the nonresponse survey.

Table 49

Truncated Mean and Median Values
Trust Fund Question

Model	Mean Logit	Median
Lower Sub. Residents	$ 16.86	$ 5.92
Middle Sub. Residents	$ 22.26	$ 8.44
Upper Sub. Residents	$ 27.44	$ 6.38
Out-Of-Basin Residents	$ 14.92	$ 3.79
Nonresident Anglers	$ 33.07	$ 5.08

Table 50

Total Value of Missouri River Basin Trust Fund

Strata	Value	Population**	Total
Lower Sub.	$ 16.86	71,953	$ 1,213,128
Middle Sub.	$ 22.26	96,110	$ 2,139,409
Upper Sub.	$ 27.44	69,730	$ 1,913,391
Out-of-Basin	$ 14.92	317,002	$ 4,729,670
	Resident annual total		$ 9,995,598
Nonresident Anglers	$ 33.07	107,512	$ 3,555,422
	TOTAL ANNUAL VALUE OF TRUST FUND		$ 13,551,020

** Resident population is 1980 census, resident over 18 years of age. Nonresident population is number of nonresident conservation licenses sold in 1989.

Table 51

Confidence Intervals on Trust Fund Valuation Figures

Model	Trunc.Mean (Std.Error)	Median (Std.Error)
Lower Sub. Residents	$ 16.86 (1.56)	$ 5.92 (.821)
Middle Sub. Residents	$ 22.26 (1.93)	$ 8.44 (1.07)
Upper Sub. Residents	$ 27.44 (2.41)	$ 6.38 (1.28)
Out-Of-Basin Residents	$ 14.92 (1.76)	$ 3.79 (.913)
Nonresident Anglers	$ 33.07 (5.31)	$ 5.08 (1.44)

Strata	Total	Std. Error
Lower Sub.	$ 1,213,128	$ 112,247
Middle Sub.	$ 2,139,409	$ 185,492
Upper Sub.	$ 1,913,391	$ 168,049
Out-of-Basin	$ 4,729,670	$ 557,924
Resident total	$ 9,995,598	$ 621,712
Nonresident Anglers	$ 3,555,422	$ 570,889
TOTAL VALUE	$ 13,551,020	$ 844,062

COMPARISON TO PREVIOUS ESTIMATES OF PRESERVATION VALUES

There have been three previous studies of the preservation values of rivers, as listed in Table 52. Walsh, Sanders and Loomis (1985) conducted a mail survey of Colorado residents to value protection of potential Wild and Scenic Rivers. Respondents were asked to value groups of from three to 17 rivers. Based on 214 responses to an open-ended CVM question, the average household was willing to pay $95 per year to a trust fund to protect 11 of the specific rivers. In 1989 dollars this is equivalent to $118 per household. For purposes of this discussion, all values from all studies have been updated to 1989 dollars as in Table 53. The total trust fund value was $140.2 million based on the Colorado resident population.

Sutherland and Walsh (1985) undertook a survey of Montana residents in 1981 to place a value on protecting water quality in the Flathead River and Lake system. Based on 171 responses to an open-ended CVM question, the average household had a value of $87.14 (Table 53). The trust fund total for Montana residents was estimated to be $17.9 million. Based on the relationship of distance to willingness to pay, a regional trust fund total (including adjacent states and provinces) was estimated at $111.1 million. These aggregated estimates exclude the direct recreational use component (which was about 12 percent) of the household valuation response.

The Colorado and Flathead River studies are not directly comparable to the current study in that they are for different river basins and for different levels of protection: "water quality" and protection from "development" through Wild and Scenic River designation. Either of the latter may be more significant improvements to the resource than a given increment to instream flow. Additionally, the responses are on a household basis. On a per person basis, the values would still be $40 to $60 per respondent, which is considerably higher than the average value per Montana resident for the current study of about $16. These differences may be due to differences in the resource being valued or (for the Walsh study) differences between Colorado and Montana residents. One can conclude that other researchers have found trust fund values for protection of river systems that are considerably higher than those found in the current study.

A more recent study by Duffield, Butkay and Allen (1990) provides a somewhat closer comparison to the current study in that instream flow values for Montana rivers were examined. These researchers undertook a household mail survey of valuation of improved instream flows for (varying across respondents) one to five Montana rivers including the Big Hole, Gallatin, Smith, Bitterroot and Upper Clark Fork. The average value for improvements on the group of all five rivers was estimated through dichotomous choice CVM at $12.14 based on a sample of 582 respondents. Improvement on only one river was valued at $5.04 per respondent. The relationship between willingness to pay and the number of rivers was positive and showed diminishing returns (consistent with economic theory). This finding was consistent with the results of Walsh, Sanders and Loomis (1985).

The five river estimate is somewhat lower than the Montana resident average of $16.19 for the current study. However, the current study was for instream flow improvement in any or all Missouri River Basin rivers - 22 specific rivers or river segments were for example listed in the use estimation section of the survey. When the results of the five river survey are extrapolated to a total of around 20 rivers, the estimated willingness to pay is around $16. In any case, one would not expect the results to correspond exactly in that the five river estimate includes several out-of-basin rivers. This simple comparison indicates that the current study's trust fund response appears to be fairly consistent with the results of Duffield, Butkay and Allen (1990).

It is interesting to note that only the Sutherland and Walsh (1985) study of the Flathead attempts to estimate a regional trust fund value. Their basic finding is that the Montana resident share is only about 15 percent of the total valuation for protecting the Flathead. Their estimate is based on extrapolating values to residents of adjacent states and provinces based on a relationship of willingness to pay and distance. For the average weighted distance of Montana residents from the Flathead area (184 miles) Sutherland and Walsh show an elasticity of willingness to pay with respect to distance of -.43 (a ten percent increase in distance leads to a 4.3 percent drop in average willingness to pay). The relationship of distance and willingness to pay was also derived in the Duffield et al. study at -.35. (The functional form of the willingness to pay models in the two studies differed; the latter is an elasticity that holds at all distances in the model.) This indicates some consistency across the models. It is not possible to derive the distance-willingness to pay relationship in the current study because the site extends across the entire state.

To conclude, it appears that there is some consistency across the various studies conducted to date on the preservation value of rivers. Results of other studies indicate that the current study's estimated value of instream flow improvements on Missouri River Basin streams may be very conservative because of excluding most of the value associated with residents of other states in the region. This study only includes the values held by nonresident anglers.

Table 52

Studies of Preservation Value of Rivers

Study	Object of Preservation
Walsh, Sanders and Loomis (1985)	protect from development 11 Colorado Wild and Scenic River candidates
Sutherland and Walsh (1985)	protect water quality Flathead River and Lake
Duffield, Butkay and Allen (1990)	improve instream flows 5 Montana rivers
Current study (1990)	maintain instream flows Upper Missouri River Basin

Table 53

Estimated Preservation Values for Rivers

Study/site	Dollars per respondent		Trust fund total (million dollars)	
	person	household	state	region
Walsh/Colorado	--	118.26	140.2	--
Sutherland/MT	--	87.14	17.9	111.1
Duffield/MT	--	12.14	7.5	--
DNRC/MT	--	16.19	10.0	--

Notes: All estimates are in 1989 dollars (based on the consumer price index). See Table 51 for complete references and description of resource being protected. All estimates include direct use as well as existence motives except the Sutherland and Walsh (1985) trust fund total which excludes direct use values.

Chapter VIII

Conclusions

The basic conclusion of this report is that there are significant recreation and preservation values associated with Missouri River Basin waters. The reader is referred to the executive summary for a narrative overview. Specific major findings are as follows:

- 9000 questionnaires were mailed to Montana residents and nonresident anglers with an overall response rate of 54 percent

- recreational use of Missouri River Basin waters in Montana totaled over 2 million recreation days in 1989

- 86 percent of total use was by residents and 14 percent by nonresidents

- 61 percent of use was on rivers and streams and 39 percent on reservoirs

- average expenditures per trip for residents were $113 and for nonresidents $640

- average expenditures per day for residents were $39 and for nonresidents $158

- total trip-related expenditures in the basin in 1989 were $70 million for residents and $45 million for nonresidents

- nonresident expenditures were concentrated (85 percent) in the Upper Missouri Basin (above Three Forks)

- nonresident expenditure was primarily on river related recreation (87 percent) as compared to reservoir use

- from the standpoint of state economic impact, far and away the most important recreational resource in the basin are the streams in the Upper Basin

- the net economic value per day of recreational activity varied from $40 to $66 across subbasins for residents

- resident net economic values are consistent with previous research and actual prices for Montana's fee fisheries

- nonresident net economic values were estimated at $193 per day for streams and $128 for reservoirs

- nonresident values reflect the higher income of these users and the relative quality of Montana fisheries

- the total net economic value of water-based recreational use in the basin is $144 million annually or a present value of $3.6 billion

- survey respondents indicated that 1988 drought-related low flows in the basin substantially reduced the number and quality of their recreational trips

- estimated instream flow values in dollars per acre foot for a change in flows varied considerably across site and time of year

- estimated July-August values varied from $68 in the Upper Basin to $11 in the Lower Basin per acre foot for a change from 75 percent of 1989 flows

- instream flow values for September-June were around $23 in the Upper Basin and $4 in the Lower Basin

- estimated instream flow values for recreation were similar to previous estimates for sites in the basin

- values of changes in reservoir contents were on the order of $1.40 to $.02 per acre foot-month across site and time of year

- respondents placed significant values on maintenance of summertime flows in the basin as evidenced by responses to hypothetical trust fund donations

- the mean trust fund donation ranged from $14 for out of basin Montana residents to $33 for nonresident anglers

- the mean trust fund donation for in-basin Montana residents ranged from $17 to $27

-total trust fund value was estimated at $13.6 million annually, which is in the same range as a previous estimate for preservation of water quality in the Flathead basin

- the trust fund value is quite conservative because of exclusion of all potential nonresident values except those held by nonresident anglers

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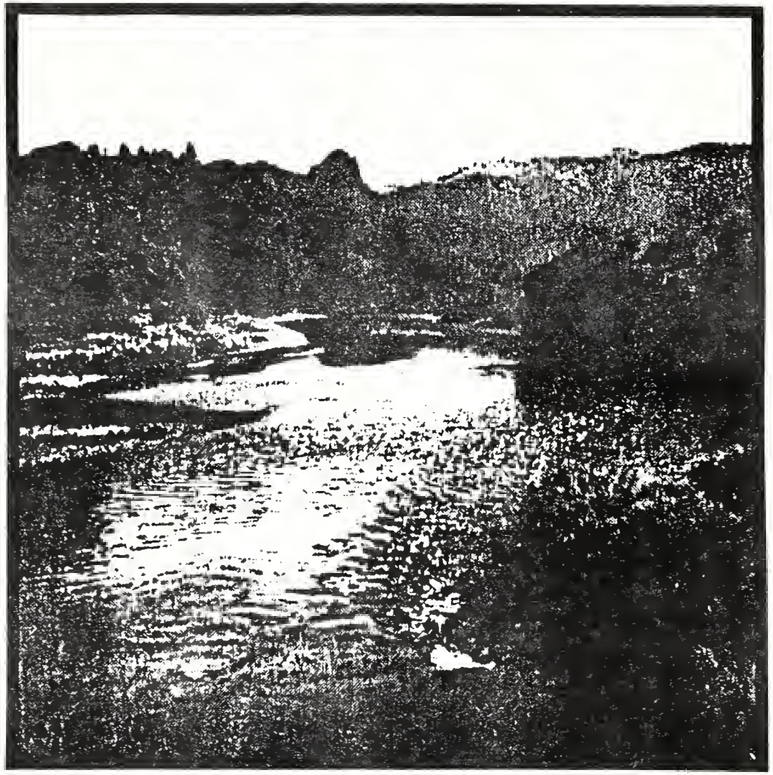
APPENDIX A:
Survey Instruments

Thank you for your help. Is there anything else you'd like to tell us about flow levels in Montana's rivers or other related issues. We would appreciate your comments.

Thanks again. If you would like to receive a copy of the results of this study, please write your name and address on the back of the return envelope (NOT on this questionnaire).

Recreation Use and Values
in the

MISSOURI
RIVER BASIN



STATE OF MONTANA

Department of Natural Resources and Conservation

I. First, we have some general questions about your opinion regarding use of Montana rivers and reservoirs. Please answer eve If you rarely or never visit rivers or reservoirs for recreation.

1. Check the box that best represents how you feel about each of the thre statements below.

	Strongly Agree	Agree	Disagree	Strongly Disagree	No Opinio
a. I enjoy knowing that my friends and family can visit rivers for recreation if they want to.	☐	☐	☐	☐	☐
b. Water quality in streams and rivers in this area of Montana should be improved.	☐	☐	☐	☐	☐
c. I think irrigation is the most important use of Montana's water.	☐	☐	☐	☐	☐

2. Do you participate in water-related recreation such as fishing, boating, o shoreline activities like picnicking, swimming, sightseeing or camping?

☐ yes ☐ no (If no, please go to Part IV)

3. About how many days so far this year did you participate in water-relate recreation?

________number of days so far this year

4. How many years have you been going to rivers or reservoirs to fish, boat o participate in other water-related activities?

________years

If you haven't visited Missouri Basin rivers or reservoirs this year (see ma on back of cover letter) please go to Part IV.

II. This Section asks about the trips you have made to eight rivers and reservoirs in the Middle Missouri River Basin of Montana. A trip can be part of a day, a full day, or several days long.

1. Which of the following rivers or reservoirs or their tributaries have you visited so far this year? (Please check each river or drainage you have visited. If you visited none of these rivers or reservoirs or their tributaries please go to #3.)

☐ Missouri R. from Three Forks to Canyon Ferry
☐ Hauser and/or Holter Reservoir
☐ Missouri River from Holter to Great Falls
☐ Missouri River from Great Falls to Fort Benton
☐ Smith River
☐ Canyon Ferry Reservoir
☐ Belt Creek
☐ Dearborn River

2. About how many trips did you make to any of these eight rivers and reservoirs or their tributaries so far this year for each of the following activities?

_______Number of trips where FISHING FROM BOAT was the main activity
_______Number of trips where FISHING FROM SHORE was the main activity
_______Number of trips where BOATING/FLOATING was the main activity
_______Number of trips where shoreline activities like PICNICKING, SWIMMING, SIGHTSEEING OR CAMPING were the main activity

3. How many more trips do you expect to make to these areas in the remaining months of 1989?

_________number of ADDITIONAL TRIPS in 1989

4. Did you make major equipment expenditures this year for river or reservoir-related equipment such as a boat, motor, trailer, rod or reel?

☐ no ☐ yes
↙
If yes, about how much did you spend? $__________

The next few questions are about trips taken in 1988.

5. Which of the following rivers and reservoirs or their tributaries did you visit in 1988? (Please check each area you visited.)

☐ Missouri R. from Three Forks to Canyon Ferry
☐ Hauser and/or Holter Reservoir
☐ Missouri River from Holter to Great Falls
☐ Missouri River from Great Falls to Fort Benton
☐ Smith River
☐ Canyon Ferry Reservoir
☐ Belt Creek
☐ Dearborn River

6. As you may recall, 1988 was a year of severe drought in Montana. How did the low water levels in 1988 affect the number of trips you took to these areas last year? (please check one)

☐ fewer trips ☐ more trips ☐ no change

7. How did low water levels on these rivers and reservoirs or their tributaries affect the overall quality of your trips in 1988? (Please check one of the following)

☐ quality was raised ☐ quality was unchanged ☐ quality was lowered

8. How did low flows in 1988 affect the type of activities that you participated in? (Please check all that apply)

☐ boated or floated less
☐ boated or floated more
☐ fished less
☐ fished more
☐ participated in less shoreline activity
☐ participated in more shoreline activity
☐ no change
☐ other_________________

9. In 1988, if you took FEWER TRIPS to any of these eight rivers and reservoirs or their tributaries, did you visit any other rivers and reservoirs instead?

☐ yes ☐ no

10. If yes, which ones? (please list alternative rivers visited)

____

____

The next few questions ask about trips you took to other areas of the Missouri River Basin in 1989.

11. Did you make any trips so far this year to the following rivers or their tributaries in the UPPER Missouri River Basin? (Please check each area visited)

☐ Big Hole
☐ Jefferson
☐ Beaverhead
☐ Ruby
☐ Gallatin
☐ Boulder
☐ Wise
☐ Madison
☐ Red Rocks

12. Did you make any trips so far this year to the following rivers and reservoirs or their tributaries in the LOWER Missouri River Basin? (Please check each area visited)

☐ Sun
☐ Judith
☐ Missouri River below Fort Benton
☐ Teton
☐ Musselshell
☐ Marias
☐ Big Spring Creek
☐ Fort Peck Reservoir

III. The next few questions ask about a specific trip you took to a river or reservoir in the Missouri River Basin. If you have not visited one of these areas in 1989, please go to Part IV. We are asking different people about trips taken at different times of the year.

1. Which Missouri River Basin river or reservoir (see map on back of cover letter) did you visit CLOSEST TO JULY 15TH OF THIS YEAR? A trip can be anything from an hour to several or more days(If the trip you took closest to July 15th was in another month, this is still ok.)

____________________NAME OF RIVER OR RESERVOIR

2. What was the approximate date of this trip?

______MONTH _____DAY

3. How many days did you spend at this river or its tributaries on this trip?

_____NUMBER OF DAYS

4. What was the MAIN ACTIVITY you participated in on this most recent trip? (please check one)

☐ fishing from shore

☐ fishing from a boat

☐ boating/floating

☐ shoreline recreation (picnicking, sightseeing, camping, or swimming)

5. Did you know what the water level in the river or reservoir or their tributaries was going to be before you visited the river? (please check one)

☐ knew exactly

☐ had a general idea

☐ had no idea

6. Would you have preferred to visit the river or reservoir or their tributaries at a different water level than what you experienced? (please check one)

☐ preferred higher water level

☐ preferred lower water level

☐ water level was good

7. What is the lowest water level at which you would visit this river or reservoir? (please check one)

☐ at the ACTUAL LEVEL I experienced

☐ 90 PERCENT of what I experienced

☐ 75 PERCENT of what I experienced

☐ 50 PERCENT of what I experienced

☐ 25 PERCENT of what I experienced

☐ 10 PERCENT of what I experienced

☐ I would visit the area NO MATTER WHAT the water level was.

☐ Other ____________________________

8. How many trips have you made to area so far this year?

_______Number of trips so far this year.

9. How many years have you been visiting this river or reservoir?

_______Number of years visiting this area.

10. How would you rate YOUR KNOWLEDGE of this river or reservoir including how different water levels affect your recreational activity? (please check one)

☐ very knowledgeable

☐ knowledgeable

☐ only somewhat knowledgeable

☐ not knowledgeable

11. About how much money did you personally spend on this trip (if anything) on each of the following categories? If you can't recall the exact amount, please give your best estimate:

Transportation expenses (gas, oil, etc.)	$______
Lodging, such as motel or campground fees	$______
Food and beverages bought in stores	$______
Food and beverages bought in restaurants	$______
Equipment (such as tackle) for this trip	$______
Other (list)____________________	$______
Total amount you spent on this trip	$ ______(TOTAL)

12. Approximately what percent of this total amount did you spend in Montana?

_______PERCENT SPENT IN MONTANA

13. Suppose that your share of the expenses to visit this area increased; would you still have made the trip if your cost had been $________ more? (please check one)

☐ yes, I would still have made the trip
☐ no

↙

If no, would you have made the trip if your share of the expenses had been only $1.00 more?

☐ yes ☐ no

↙

If no, could you please indicate why not (check one):

☐ I could not afford the additional cost.
☐ I would have gone elsewhere if the cost increased.
☐ I already pay taxes to use public resources.
☐ I am opposed to fee recreation.
☐ I live close by so costs could not be that high.
☐ other______________________________

IV. This section asks how familiar you are with efforts to conserve natural resources — and about your own willingness to become involved.

1. In various parts of the country, trust funds have been set up to purchase water or land resources to conserve unique natural resources. The Nature Conservancy, Ducks Unlimited and the Rocky Mountain Elk Foundation are examples of the types of groups that can do this. How familiar are you with these efforts? (check one)

☐ I have never heard of such trust funds
☐ I have heard of them but don't know much
☐ I know a fair amount about them
☐ I know a great deal about them

2. Have you ever been a member of or donated money or time to a trust fund like this, or to other efforts to conserve natural resources such as rivers or wildlife habitat?

☐ yes, I have
☐ no, I have not

As you may be aware, sections of some Missouri Basin rivers such as the Big Hole, Gallatin, Smith, Sun, Judith and Musselshell typically have had low summertime flows. Low flows can often occur in other basin streams, especially in drought years. Often, existing flows in streams are not legally protected and could be reduced by new diversions of water.

To help protect existing flows, a private trust fund could be established to purchase or lease water to maintain fish, birds, wildlife and plants, and recreational uses. This would benefit people who use these rivers for recreation as well as those who believe having water in rivers is important. The effectiveness of the trust fund would increase with the amount of money contributed to it.

3. If you were contacted within the next month, would you pledge to make an annual contribution of $__________to help buy the water needed to maintain summer flows on Missouri Basin streams?

☐ yes (please go to #6)
☐ no (please go to #4)

4. Would you be willing to donate a smaller amount, such as $1.00 per year, to help purchase water when needed for these rivers?

☐ yes (please go to #6)
☐ no (please go to #5)

5. Could you please give your reason for not wanting to purchase an annual membership in this trust fund?

(After answering #5, please go to section V.)

6. Are there any of these nineteen Missouri Basin streams that you think should receive a higher priority from the trust fund? If so, which ones? (check up to three)

☐ Red Rocks
☐ Big Hole
☐ Ruby
☐ Beaverhead
☐ Jefferson
☐ Gallatin
☐ Madison
☐ Boulder
☐ Dearborn
☐ Smith
☐ Sun
☐ Belt Creek
☐ Missouri R. from Three Forks to Canyon Ferry
☐ Missouri R. below Great Falls
☐ Teton
☐ Marias
☐ Judith
☐ Musselshell
☐ Big Spring Creek

V. This final section will help us to understand the responses we receive.

1. Are you a member of any conservation, sport fishing, or boating organizations? (please check one)

☐ yes ☐ no

2. What kind of area do you live in? (please check one)

☐ in a town or city
☐ on the outskirts of a town or city
☐ in a rural area

3. What is your age? ______Years.

4. Are you: ☐ male ☐ female

5. What is the highest year of formal education you completed?

☐ some grade school
☐ finished grade school
☐ finished junior high
☐ finished high school
☐ some college
☐ finished college
☐ some postgraduate
☐ finished postgraduate

6. Which of the following best describes your occupation? (please check one)

☐ agriculture
☐ service or trades
☐ professional
☐ other:______________________
☐ retired
☐ homemaker
☐ student

7. Please check your household's income before taxes last year.

☐ under $5000
☐ $5,000-9,999
☐ $10,000-14,999
☐ $15,000-19,999
☐ $20,000-24,999
☐ $25,000-29,999
☐ $30,000-34,999
☐ $35,000-39,999
☐ $40,000-49,999
☐ $50,000-74,999
☐ $75,000-100,000
☐ over $100,000

DATE ______________________

NONRESPONDENT # ____________

MONTANA DNRC MISSOURI RIVER BASIN STUDY
NONRESPONSE TELEPHONE SURVEY SCRIPT

Hello. Is ______________________ home? (If NO, call back when?)

I'm ______________ calling from the Montana Department of Natural Resources and Conservation in Helena about a survey we've been conducting on recreation in the Missouri River basin. I'm calling people who didn't respond to our study to just ask a few questions. This is not a request for money. Could I have a few minutes of your time? (If NO, thanks anyway. If YES, proceed.)

1. Do you participate in any of the following recreation activities: fishing, boating, swimming in rivers or lakes, or picnicking, sightseeing, or camping beside rivers or lakes?

   _____YES _____NO (if NO, skip to question #3)

2. About how many days so far this year did you participate in water-related recreation?

   _____ number of days so far this year

3. Are you a member of any conservation, sport fishing, or boating organization?

   _____YES _____NO

4. What kind of area do you live in? Is it a: (CHECK ONE)

   _____ town or city
   _____ on the outskirts of a town or city
   _____ in a rural area

5. What is your age? _____years

6. What is the highest level of formal education you have completed?

   _____ some grade school
   _____ finished grade school
   _____ finished junior high
   _____ finished high school
   _____ some college
   _____ finished college
   _____ some postgraduate
   _____ finished postgraduate

7. Which of the following best describes your occupation?

   _____ agricultural
   _____ service or trades
   _____ professional
   _____ other ______________________________
   _____ retired
   _____ homemaker
   _____ student

Thanks very much for your help. Goodbye.

INTERVIEWER RECORD:

Survey # ______________

Sub-basin area ______________

_____MALE _____FEMALE

CITY/TOWN-______________

Montana Department of
Fish, Wildlife & Parks

FISHERIES SURVEY

DID YOU FISH IN MONTANA
DURING AUGUST 16-31

☐ YES ☐ NO

PLEASE CHECK THE TYPE OF LICENSE YOU PURCHASED

☐ FISHING OR FISHING/CONSERVATION COMBINATION FOR RESIDENT OR NONRESIDENT
☐ SPORTSMAN
☐ DISABLED RESIDENT CONSERVATION
☐ RESIDENT CONSERVATION ONLY

IF YOU ARE A PIONEER (62 OR OLDER) OR A YOUTH (12 TO 14), DO YOU PLAN ON USING YOUR CONSERVATION LICENSE TO FISH?

☐ YES ☐ NO

PLEASE REFER TO THE MAPS TO HELP US IDENTIFY THE WATERS YOU FISHED

DATE FISHED AUGUST 16-31	NAME OF LAKE OR STREAM FISHED	SECTION NUMBER IF INDICATED ON MAP	NEAREST TOWN AND/OR POINT OF ACCESS OR LANDMARK	TOTAL HOURS FISHED PER DAY	TOTAL NUMBER OF FISH CAUGHT		TOTAL NUMBER OF FISH KEPT		WAS THE MAIN PURPOSE OF YOUR TRIP TO FISH? (Y OR N)	DID YOU STAY OVERNIGHT? (Y OR N)	ROUND TRIP DISTANCE** TRAVELED
					TROUT AND SALMON	OTHER SPORT FISH*	TROUT AND SALMON	OTHER SPORT FISH*			
ENTER EACH DAY AND EACH WATER FISHED ON A SEPARATE LINE. LIST ALL FISHING IN MONTANA, NOT JUST WATERS INDICATED ON THE MAP											
AUGUST											
AUGUST											
AUGUST											
AUGUST											
AUGUST											
AUGUST											
AUGUST											
AUGUST											
AUGUST											

* SUCH AS: THE NUMBEROF WHITEFISH, WALLEYE, PERCH, BASS, ETC.

** IF YOU STAYED OVERNIGHT, PLEASE MAKE A SEPARATE ENTRY FOR EACH FISHING TRIP.

THIS INFORMATION WILL BE HELD IN STRICT CONFIDENCE AND WILL BE USED FOR MANAGEMENT PURPOSES ONLY

APPENDIX B:
Computational Notes

This appendix is intended to provide a more detailed discussion of the computational procedures used in this study than was presented in the main report text. The computational notes are presented in the order of the tables with which they are associated.

The DNRC Missouri River Basin survey was administered in a stratified manner. Since this was a general household survey cost considerations dictated that sampling be targeted to specific user groups in order to achieve the desired response sample sizes. The strata included: Upper Missouri Basin residents, Middle Missouri Basin residents, Lower Missouri Basin residents, residents living outside the Missouri Basin and nonresident conservation license holders.

Stratified sampling is commonly employed for several reasons. Often an increase in precision can be gained through the use of sample stratification, and sampling resources can be allocated more efficiently through the use of stratification (Snedecor and Cochran, 1968). One difficulty regarding the analysis of stratified data, however, is that all analysis of the resulting data should also be done in a stratified manner. The major problem this presents is that sample sizes are divided at best by the number of strata (in the case of equal sample sizes for all strata). These smaller sample sizes can present problems for certain types of statistical analysis, especially logistic regression which is used heavily in this study.

In an effort to eliminate the problem of reduced sample sizes an alternative method of stratifying was used for data analysis in this study. As is traditionally done in studies such as this the nonresident strata was examined independent of the resident stratas. Nonresidents are consistently different from residents in their spending levels, lengths of stay and net economic valuations. An analysis of the resident strata was then performed to determine if the strata means for expenditures, length of trips, and net economic values were significantly different, or whether the resident strata could be pooled without significantly biasing the results. For nearly all levels of aggregation it was found that no significant difference between resident means existed. Where differences were found to exist, the pooled estimates provided underestimates of the expenditure levels and net economic values, thus erring on the conservative side.

The results in this study are therefore presented for two strata, residents and nonresident conservation license holders (anglers), rather than for the five strata of the original survey design.

Following is a list of the tables in the text along with any relevant computational notes regarding them.

Table 2

Statistics are simple sample proportions.

Table 3 and 4

Statistics are simple sample proportions and means. Average family income was reported as one of 12 ranges of income from 5000 to over 100000 dollars. responses were coded to the midpoints of the range indicated, and the over 100,000 responses were coded to 125,000 dollars.

Tables 6,7,8 and 9

Estimates are the sums of individual water, angler use estimates made by DFWP. The assumption of independence between water estimates was made and the standard errors for the aggregate use estimates were calculated as the square root of the sums of the variances.

Tables 10,11,12 and 13

Respondents were asked to select one of four activities as the main activity of their trip. While most marked only one main activity nearly 20% marked more than one activity. These multiple answers were recoded from 1's to 1/2, 1/3, or 1/4 depending on the number of activities marked. The angler proportion was calculated by summing the proportions of use for the two angler activity classes. The standard errors for these estimates were calculated as:

$$\text{Standard Error} = \text{sqrt}\ [\ (P \times 1-P)\ /\ n\ ]$$

Though this formula is exact only if all the data is zeros and ones, it will overestimate the standard error slightly when there are some fractional entries.

Tables 14, 15, and 16

Estimates in these tables were calculated as total angler days divided by angler proportion. Since these estimates are from different samples, they are independent. The covariance term is therefore=0 and is dropped from the standard variance of a ratio formula. The standard errors for this estimate of total use days were calculated as:

$$\text{Std.Err.}(D/P) = 1\ /\ P^2\ [\ \text{VAR}(D) + D^2/P^2\ \text{VAR}(P)\ ]$$

Where: P = angler proportion, D = Total angler use days.

Tables 17, 18, 19 and 20

These tables present explicit 95% confidence intervals around the estimated use means. The confidence intervals were calculated as:

estimated mean + or - 1.96 (std.err.)

Tables 21 and 22

Current study statistics are sample means for those respondents who indicated that fishing was the main activity of their trip.

Table 23

The per trip expenditure figures are simple means of all non-missing total expense figures for each cell of the table. Standard errors are calculated as:

Standard Error = std. dev. /sqrt(n)

Table 24

Same procedure as above for length of current trip.

Table 25

Estimated average expenditures per day are average expenditures per trip divided by average days per trip. The variance estimates for average expenditures were bootstrapped from the survey data. An approximate variance was also calculated to check the general accuracy of the bootstrapped estimate. These approximate variances were consistently quite close to the bootstrapped variances. The approximate variances were calculated as:

$$VAR(E/D) = 1/ND^2\ [VAR(E_i) + E^2/D^2\ VAR(D_i) - 2E/D\ COV(E_i, D_i)]$$

Where:
E = mean expenditures per trip
D = mean days per trip

Table 26

The average expenditures per trip for specific activity types were calculated as the simple means of total, non-missing expenditures. The Standard Errors were calculated as:

Standard Error = Std.Dev. / sqrt (N)

Table 27

This table provides a more detailed breakout of expenditures per day by activity type. This was calculated as average expenditure per trip divided by average days per trip. Due to the complexity of bootstrapping standard errors for ratios such as this, no measures of variance were calculated for this specific breakout.

Table 28, 29 and 30

Total recreational expenditures were calculated as average expenditures per trip times total recreational use days. The variance for this statistic is calculated as:

$$VAR(E \times TUD) = (TUD)^2 \; VAR(E) + E^2 \; VAR(TUD)$$

Where:
E = average expenditures per day
TUD = Total recreational use days

Table 33

Average Net Economic Value per Day was calculated using two methods: 1) The truncated mean was calculated through numerical integration of the estimated bivariate equations shown in Table 31. The upper level of integration for these models was the maximum bid level, or $500 for residents and $2000 for nonresidents. 2) The median was calculated as

$$MEDIAN = \exp(-a/b),$$

with a and b being the coefficients from the bivariate equations of Table 31. The standard errors for this table were bootstrapped following the methodology of Duffield and Patterson (1990).

Table 34

Average net economic value per day was calculated as average net economic value per trip divided by average number of days per trip. In calculating standard errors for this ratio the assumption of independence between value per trip and days per trip was made. While this assumption is not supported by evidence, the variances estimated under it will be overestimates of the true variances, and thus conservative. The formula for calculating these variances was

$$var(x/y) = 1/y^2 \; var(x) + x^2/y^4 \; var(y).$$

where:
x=mean economic value per trip
y=mean days per trip

Table 35

Total net economic value was calculated as average net economic value per day times total recreational user days. The calculation of a variance for this estimate used the following formula:

$$var(NEV \times TUD) = var(NEV)\, var(TUD) + NEV^2 \; var(TUD) + TUD^2 \; var(NEV)$$

where:
NEV=Net economic value per day
TUD=Total recreational user days

Tables 37, 38, 39 and 40

As was discussed in the text, the marginal values for flows were calculated directly from the total value figures of Table 35 and the bivariate flow/visitation equations of Table 36. The derivative of the estimated flow/visitation equations (shown in equation 23) was used to directly compute the marginal values using equation 24) from the text. Standard errors on these values are a direct product of the standard errors on total net economic value. Of the marginal value equation

$$\text{M.V.} = \frac{dP/dF * \text{total value}}{\text{Total Discharge}/100}$$

only total value was treated as an estimate with an associated standard error. Hence, the equation for the variance of M.V. can be written as

$$\text{var (M.V.)} = k^2 \ \text{var(total value)}$$

where:

$$k^2 = (dP/dF) / (\text{total discharge}/100)$$

As stated in the text, these standard errors are only approximate and care must be taken in their interpretation.

Table 41

Average value figures were calculated as

$$\text{A.V.} = \text{total value} / \text{total discharge}$$

Table 44

The truncated means and medians for the trust fund analysis were calculated using the same methodology as that used for the current trip analysis. Refer to Table 33.

Table 45

The total value figures are the products of the components in the table.

Table 46

The standard errors for the trust fund valuation figures were calculated using bootstrapping of regression coefficients as was done in Table 33. The aggregated standard errors were calculated as

$$\text{Std.Err.(total trust fund value)} = \text{sqrt}(\text{pop.}^2 \ \text{var(economic value)}).$$

APPENDIX C:
Bid Distribution Analysis: DNRC Missouri River Basin Recreation Study

BID DISTRIBUTION ANALYSIS
DNRC MISSOURI RIVER BASIN RECREATION SURVEY

John Duffield
David Patterson
Susan Butkay

August, 1989

INTRODUCTION

This note describes the design of the bid distribution for the Montana Department of Natural Resources and Conservation (DNRC) Missouri River Basin recreation survey.

The DNRC survey contains two dichotomous choice valuation questions: valuation of instream flows through a trust fund payment vehicle and valuation of recent recreational trips through a trip expense vehicle. Both questions are designed to be analyzed using logistic contingent valuation methods. This method requires that each respondent be faced with specific bid offers, which are randomly varied across respondents. Design of these bid distributions entails the following basic choices:

1. choice of welfare measure
2. sample size
3. bid range
4. bid levels
5. allocation of sample among bid levels

These choices must be evaluated for each question type (trust fund and recent trip) and for two populations: Montana residents and nonresident anglers.

WELFARE MEASURE

Where the purpose of the contingent valuation exercise is to provide estimates of total value associated with a given resource, the appropriate welfare measure is the truncated mean. The basis for that choice will be briefly described.

Previous research indicates that the most successful functional form for logistic regression on recreation and instream flows includes a log transformation of the key independent variable (the bid offer). The normal mean for this functional form is infinite in many cases because the of the large upper tail of the distribution. Accordingly it is necessary to truncate the mean at some level. The usual approach is to truncate the mean at the highest observed bid level. This suggests that the choice of bid range, and particularly the highest bid level, is an important one.

The main alternative to the truncated mean is the median. The median is the bid amount which 50 percent of the sample population are willing to pay. For most applications the median is considerably smaller than the truncated mean because of the large upper tail of the response distribution. In other words, a relatively small number of people with very high values can result in the mean being substantially larger than the median. The result is that the median may provide a substantial underestimate of the "average" value placed on the given resource. The advantage of the median is that it is more robust. The median is not as sensitive to the design of the bid distribution and does not require information on the upper tail of the distribution. While we advocate designing for the truncated mean, we will of course report the median in all applications.

Our conclusion on this point is that the bid distribution should be designed to provide an efficient estimate of the truncated mean.

SAMPLE SIZE

Target sample sizes for the two questions are 600 for the trust fund question and 300 for the recent trip. These general targets were established based on the precision of logistic contingent valuation estimates in the economics literature. Duffield and Patterson (1989) provide several methods for estimating the variance (and related confidence interval) for the truncated mean. These methods applied to a well-known data base (Bishop and Heberlein, 1980) indicate that 90 percent confidence intervals that are plus or minus 10 to 20 percent of the estimated mean can be estimated with samples of 300 to 600. However, other applications indicate that even larger samples may be needed to achieve these levels of precision. The general characteristics that relate a given estimate to the level of precision are as yet not well understood. Most estimates in the published literature have used samples on the order of 100 to 200 and some estimates are reported for samples of only 25 to 50 observations.

Duffield and Patterson (1989) also provide an equation (p. 19) that relates estimated standard error for the truncated mean to sample size, given the estimated logistic regression equation and the predicted response proportions.

BID RANGE

A major design choice is the bid range. At the lower end, we find it very efficient to use a $1 bid offer following the main bid question to identify protest responses. As no lower offer (the log of $1 is zero) results in positive transformed bid offers, $1 is used as the lowest bid offer.

There are at least two different perspectives to consider in selecting an upper bid level for an experiment designed to produce a truncated mean welfare measure. One perspective raises a distributive issue that may require a value judgement on the part of the policy makers who are expected to utilize the study results. The basic question is how much should one person's (or a small group of persons) values contribute to the estimated mean value. For example, one individual in the sample population may be willing to contribute $5000 to an instream flow trust fund. If the rest of the sample will contribute an average of $10, including this individual in even a sample of 600 respondents almost doubles the estimated mean to $18. As a practical matter (or from a distributive or equity standpoint), one may decide to not include values above a certain dollar level as "not being representative". Alternatively, given an idea of what the response distribution looks like, one may choose to exclude values held by only a small part of the population (eg. exclude responses where the percent willing to pay that amount is less than 5 percent or less than 1 percent). A related reason for possibly excluding responses where one individual significantly influences the average is that there may be a question about the validity of these responses. The implication of this perspective is that if one has a good idea of the shape of the response distribution, the upper bid level can be set at some selected minimum response proportion, such as 1 percent or 5 percent.

A second perspective on setting the upper bid level is the tradeoff of survey costs (sample size), precision of the estimate and the extent to which the truncated mean provides a conservative estimate. The basic relationships here are that, other things equal, the higher the upper bid (and correspondingly the truncation level for the truncated mean) the more closely the estimated truncated mean will approach the true population mean. On the other hand, given sample size, the higher the truncation level the less precise the estimate. In other words, it can be very costly to precisely estimate the upper end of the response distribution. These tradeoffs can be quantified given a previous estimate of the likely response distribution.

The remainder of this section describes the specific analysis for the upper bid level for each of the bid questions and populations. The sequence of this analysis is to first identify plausible prior estimates of what the actual response distribution will probably look like. Where these prior estimates are actual logistic regression equations, response probabilities at a range of upper bid levels can be calculated. Finally, the methods developed by Duffield and Patterson (1989) are applied to estimate truncated mean and associated standard error for several alternative truncation levels.

PRIOR ESTIMATES

Typically bid distributions are designed based on pretests or pilot tests of the actual survey instrument. For example Boyle, Welsh and Bishop (1988) suggest using an open-ended CVM question in the pretest. This approach may be costly in that a fairly large pretest sample may be required to get sufficient responses. Fortunately for the case at hand, results from previous related studies conducted in Montana can be utilized to provide an estimate of the likely shape of the response distribution.

With regard to the current trip question, a very similar question was asked of Montana resident and nonresident anglers for a set of 19 Montana rivers (Duffield and Allen, 1988). The range of values on these rivers based on a multivariate equation was $38 per trip to $228 per trip. One of these rivers was the mainstem Missouri from Holter to Cascade with a value of $60 per trip, making it one of the four lowest-valued waters (along with the Bitterroot, Kootenai and Middle Yellowstone) in this group of rivers. It is our judgement that the response to the Missouri may be typical of the average response for all waters in the Upper Missouri Basin. Some of the highest valued rivers are in this basin (such as the Big Hole and Madison), but so are a number of lesser valued rivers and tributaries. No direct CVM results are available on reservoirs in this basin, however travel cost model results for both streams and reservoirs in Montana (Duffield, Brooks and Allen, 1987) suggest that Missouri Basin reservoir values will be similar to the low end river values. A bivariate logit equation for the Missouri, based on a sample of 157 respondents to a mail survey, is:

$$\text{(1)} \qquad L = \underset{(18.48)}{4.35782} \; \underset{(-6.14)}{-1.40332 \ln(\text{Bid})}$$

(t-statistic):

This equation provided an excellent fit to the data and highly significant estimates for the parameters. The highest bid level in the sample was $300 and the probability of a yes response at this level was 3 percent. The use of this river is mainly by residents which comprise 82 percent of respondents in this sample. By comparison, residents are only 33 percent of the respondents on the Madison. Accordingly, the Missouri equation is taken as good prior estimate of resident responses to the current trip question on Missouri Basin waters.

For nonresident responses, the Madison might provide a good estimate, however at the highest bid level in the sample ($500), the probability of a yes response from the fitted equation was 20 percent, indicating that the offer bid levels were not sufficiently high to identify the upper end of the distribution. This was a problem for all the high value Missouri basin rivers in the Duffield and Allen (1988) sample. Alternative estimates are available from a study in progress for the Big Hole and Bitterroot Rivers. In this study, which was conducted on-site, a similar current trip valuation question was asked and the upper bid level was set at $2000. The estimated logit equation for the Big Hole is:

$$\text{(2)} \qquad L = \underset{(30.79)}{5.2195} \; \underset{(-11.9)}{- 1.12982 \ln(\text{bid})}$$

(t-statistic)

Again the estimated parameters are highly significant. The predicted probability of a yes at \$500 is .14 and declines to .03 at \$2000. Nonresident use is concentrated on the better waters, so it may be appropriate to use the response to a river like the Big Hole. On the other hand, reservoirs will be less valuable and even among rivers used by nonresidents, the Big Hole is one of the best. These tradeoffs are difficult to predict. We are choosing to temper the influence of using the Big Hole by taking an equation that includes both residents and nonresidents in the sample.

A prior estimate of the response to the trust fund is available from a mail survey of resident and nonresident households undertaken in 1988. The trust fund question in the latter study is very similar to the one considered here, although for a smaller set of rivers. The estimated equation, based on a sample of 554 households is:

$$(3) \qquad L = 1.3682 \;\; - \; 1.17126 \ln(\text{bid})$$
$$\text{(t-statistic)} \quad (22.80) \qquad (-6.82)$$

The upper bid in this sample was \$300, and the probability of a yes at that bid level was less than 1 percent (.49 percent). The above equation includes responses from about 70 nonresidents (city of Spokane), but the resident-only equation is not significantly different. Accordingly, this equation is an appropriate prior estimate for the resident trust fund question.

No existing studies have been designed specifically to estimate nonresident angler response to a trust fund question. However, an estimate for this type of question can be developed from an on-site survey conducted in the summer of 1988 on the Big Hole and the Bitterroot. Excluding residents from the sample, an equation for nonresident only response to a hypothetical trust fund for instream flow on the Bitterroot is:

$$(4) \qquad L = 1.27724 \;\; - \; .65054 \ln(\text{bid})$$
$$\text{(t-statistic)} \quad (18.9) \qquad (-3.4)$$

The upper limit in this sample of 52 nonresidents was \$1000, with a probability of a yes response being 4 percent at that bid level. The nonresident only equation for the Big Hole is similar with a probability of a yes at \$1000 being 7 percent.

ANALYSIS OF UPPER BID LEVEL

If the preceding four equations are accepted as prior estimates of the likely response distributions to be obtained in the Missouri River Basin survey, the simplest way to pick an upper bid level is to identify a minimum response proportion level and solve for the corresponding bid. For example, suppose that the upper bid level should provide observations for bids to the point where the probability of a "yes" response is 1 percent or 5 percent, then the following approximate upper bid levels would be indicated:

bid level eliciting a response of:		1% yes	5% yes
residents:	trust fund	$200	$40
	recent trip	$500	$200
nonresidents:	trust fund	$8000	$700
	recent trip	$6500	$1500

The estimates for the resident versions seem "reasonable" by comparison with bid levels used in previous research. The nonresident levels seem implausibly high and perhaps mainly reflect the fact that the upper end of the response distribution for this population strata is not well defined by previous estimates. It should be noted that the estimate for nonresident respondents to a trust fund question is based on a very small sample (52).

Another perspective on the upper bid level choice is obtained by looking at the effect of truncation level on mean and standard error (given the estimated equation and holding sample size constant). For example, Table 1 shows this relationship for the prior estimated resident trust fund equation (Equation 3).

Having a lower upper bid level means of course that the upper end of the response distribution is not identified and that the estimated truncated mean is more of an underestimate. For example, at $100 truncation, the mean is about 20 percent lower than at $300 ($8.17 versus $10.07). On the other hand, the estimate at $100 is more precise with a coefficient of variation of .12 as opposed to .17 for the mean truncated at $300. It would appear that in this case $200 might be a good compromise, as the mean is only slightly lower than at $300. Additionally, the lower bound for a 90 percent confidence interval on the mean at $200 is almost identical to the lower bound at $300 (due to the gain in precision) (see Table 1). Using $200 also seems justified based on the criteria of having an upper bid that is sufficiently high to take the response down to 1 percent.

A similar analysis supports using $500 for the upper bid level for the resident most recent trip question. A bid of $500 again corresponds to a one percent "yes" response proportion and the level of precision is about the same as for the resident trust fund. Specifically, for the resident recent trip question (based on equation (1), at an upper bid of $500 (and an equal truncation level) the truncated mean is $50.20, the standard error is 6.43 and the coefficient of variation is .13 (all based on a sample of 300). This is slightly more precise than the resident trust fund question with a coefficient of variation of .15 at an upper bid of $200 and for a sample of 600.

One approach to the nonresident bid design, given a lack of specific information, would be to use the same distribution as for the residents. However, it does appear that nonresidents do have higher average values. Somewhat judgementally, we would recommend using an upper bid level of $500 for the nonresident trust fund and an upper bid level of $2000 for the nonresident recent trip. Based on equations (2) and (4) for nonresidents, these correspond to 6 percent and 3 percent positive response proportions at the upper bid levels for the trust fund and recent trip questions respectively.

BID LEVELS

The main consideration in choice of the number and location of bid levels is to have sufficient bids to identify the appropriate functional form for model to be estimated. If one was certain that a linear functional form was the correct specification or knew which particular nonlinear form was correct (such as a logit), two points would be adequate. However, from experience we only know that the best-fitting model in dichotomous choice applications will be nonlinear, but we don't know in advance the specific best functional form.

In order to establish functional form, we have conducted surveys with as many as twenty bid levels. The problem with having many bid levels is that there may be insufficient observations at each point to conduct satisfactory goodness-of-fit tests. Our general recommendation is to have eight to nine bid levels. This provides sufficient points to identify functional form, but is few enough to provide an adequate number of observations at each bid level to do chi-square goodness-of-fit tests.

As to specific bid location, we have generally found the best fit to be with a log transformation of the bid variable. Accordingly, to get bid levels well-spaced for estimation, we generally locate bid levels at approximately equal log intervals. Given the upper bid level (or truncation point) and a lower bid level of $1 (for protest response analysis), the other seven or eight bid levels are then set at approximately equal log intervals.

It may be noted that exactly equal log intervals might imply bids like $13.61 or $73. We generally pick numbers that are close to these but rounded to the nearest $5 or $10 or even $100 in higher bid levels. We have noticed in the past that response proportions to "unrounded" numbers can be significantly different than the response to nearby "rounded" numbers. There is additionally something odd about asking someone to respond to a very large unrounded number like $259. Perhaps it implies a greater precision than the respondent feels is appropriate in the given context.

Given the upper bid levels described above, the specific bid locations for each survey-sample are as follows:

resident trust fund: 5, 10, 15, 25, 40, 50, 100, 200
nonres. trust fund: 5, 10, 25, 50, 100, 200, 300, 500
resident recent trip: 5, 10, 25, 50, 100, 200, 300, 500
nonres. recent trip: 5, 10, 25, 50, 100, 250, 500, 1000, 2000

ALLOCATION OF SAMPLE AMONG BID LEVELS

Based on Duffield and Patterson (1989), we recommend allocating the sample among bid levels to provide the most efficient estimate of the truncated mean. As described below, this basic approach can also be modified to accommodate the requirements of the chi-square goodness of fit test for a minimum number of observations in each response cell. In short, our basic strategy is optimization of the variance of the truncated mean subject to the constraint on minimum shares imposed by goodness-of-fit considerations.

Under the assumption that survey costs are constant across bid levels, it has been shown that the "optimal" sample allocation (in the sense of minimizing the standard error on the estimated truncated mean) is given by:

(5) $n = N x [p (1-p)] / x [p (1-p)] \quad j = 1,\ldots..m$

where n = number of observations allocated to bid level j
N = total sample size
x = bid interval associated with bid level i or
$= (x - x)/2 \quad j = 2,\ldots, m-1$
and $x = x + (x - x)2$
and $x = (x -)/2$
p = response proportion at bid level j

Note that the optimal sample proportions n/N are independent of N. Accordingly, given a prior estimate of the likely response proportion (p) at each i bid level, the optimal sample proportion can be identified and used to distribute any given N sample size among the i bid levels. Compared to an equal distribution of the sample among bid levels, the rule in equation (5) leads to placing a greater proportion of the sample at bid levels that are associated with a large bid interval and/or a response proportion close to 50 percent. Generally the variance of the truncated mean estimate is reduced by about 25 percent by following an optimal as opposed to equal distribution of bids in applications we have examined.

We have calculated optimal shares for each of the four question-sample combinations using predicted response proportions from equations (1) to (4). These results are in Table 2. Calculated optimal shares for some of the lower bid levels are quite low, for example .01 at the $25 bid level for the nonresident current trip. This is because the contribution of the $25 bid level to the mean and variance for this case is trivial (since the bid levels run all the way to $2000).

While the "optimal" allocation will minimize variance of the estimate, it creates a problem for implementing the chi-square test. Accordingly, we also provide a modified optimal share in Table 2. We have judgementally allocated a minimum of 5 to 7 percent of the sample to each bid level. Given our sample sizes and likely response proportions at the lower bid levels, this strategy is intended to provide a minimum of 5 to 10 responses in each response cell for the goodness-of-fit test.

RANDOM BIDS

Random bids in sets of 1000 are generated using the statistical software package "S". The only inputs required are the bid levels and the sample allocation among bid levels.

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Table 1

Effect of Upper Bid Level on Mean and Dispersion for Resident Trust Fund Response

	upper bid level		
	100	200	300
Probability of a yes	.0175	.0079	.0049
Estimated truncated mean	8.17	9.44	10.07
Standard error	.95	1.41	1.73
Coefficient of variation	.12	.15	.17
Lower 90% confidence bound for truncated mean	6.61	7.12	7.22

Notes: Based on equation (3) and a sample of 600. Truncated mean and standard error based on discrete approximation.

Table 2

Allocation of Sample among Bid Levels by Question and Sample

Bid Level	Optimal Share	Modified Share
A. Resident Trust Fund		
5	.11	.11
10	.06	.07
15	.08	.08
25	.10	.10
40	.08	.08
50	.17	.17
100	.28	.28
200	.12	.11
B. Resident Recent Trip		
5	.02	.07
10	.04	.07
25	.09	.08
50	.14	.13
100	.21	.20
200	.18	.17
300	.21	.20
500	.10	.08

Table 2 (cont.)

C. Nonresident Trust Fund

5	.02	.07
10	.03	.07
25	.06	.07
50	.10	.09
100	.17	.15
200	.20	.18
300	.26	.25
500	.15	.12

D. Nonresident Current Trip

5	.00	.05
10	.00	.05
25	.01	.05
50	.03	.05
100	.09	.06
250	.15	.12
500	.23	.20
1000	.33	.30
2000	.15	.12

Notes: Optimal share column may not add to 1.00 due to rounding. Optimal share based on predictions from equations (1) to (4).

APPENDIX D:
Detailed Flow / Valuation Tables

ACRE FOOT VALUATION OF INSTREAM FLOWS
JULY AND AUG SUBSAMPLE
UPPER SUBBASIN
RESIDENTS
RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.02673	0.001250	2.2993	0.46637
2	5	0.03505	0.001628	2.9929	0.60705
3	10	0.04585	0.002109	3.8780	0.78657
4	15	0.05981	0.002717	4.9953	1.01320
5	20	0.07772	0.003473	6.3859	1.29524
6	25	0.10050	0.004397	8.0846	1.63979
7	30	0.12917	0.005498	10.1104	2.05068
8	35	0.16475	0.006771	12.4512	2.52546
9	40	0.20815	0.008183	15.0473	3.05201
10	45	0.26002	0.009666	17.7747	3.60522
11	50	0.32046	0.011115	20.4394	4.14569
12	55	0.38890	0.012393	22.7884	4.62213
13	60	0.46390	0.013350	24.5477	4.97897
14	65	0.54321	0.013857	25.4811	5.16828
15	70	0.62396	0.013842	25.4523	5.16244
16	75	0.70309	0.013305	24.4656	4.96232
17	80	0.77777	0.012326	22.6646	4.59703
18	85	0.84577	0.011034	20.2896	4.11530
19	90	0.90572	0.009579	17.6147	3.57277
20	95	0.95707	0.008098	14.8903	3.02017
21	100	1.00000	0.006693	12.3064	2.49610

PREDICT =The predicted visitation rate for each flow.
MARG =The marginal value per acre/foot of water.
SEMARG =The standard error of the marginal value.
DERIV = First derivative of the flow/visitation model
FLOW = Percentage of actual flows

ACRE FOOT VALUATION OF INSTREAM FLOWS
REST OF YEAR SUBSAMPLE
UPPER SUBBASIN
RESIDENTS
RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.01813	0.001076	0.59272	0.12022
2	5	0.02499	0.001474	0.81168	0.16463
3	10	0.03437	0.002009	1.10613	0.22435
4	15	0.04709	0.002719	1.49745	0.30372
5	20	0.06425	0.003648	2.00912	0.40751
6	25	0.08713	0.004836	2.66345	0.54022
7	30	0.11722	0.006310	3.47516	0.70486
8	35	0.15607	0.008065	4.44121	0.90080
9	40	0.20507	0.010037	5.52763	1.12116
10	45	0.26507	0.012089	6.65734	1.35030
11	50	0.33591	0.013995	7.70719	1.56324
12	55	0.41607	0.015478	8.52412	1.72893
13	60	0.50252	0.016276	8.96363	1.81808
14	65	0.59105	0.016232	8.93890	1.81306
15	70	0.67703	0.015353	8.45499	1.71491
16	75	0.75634	0.013813	7.60674	1.54286
17	80	0.82611	0.011879	6.54181	1.32686
18	85	0.88495	0.009827	5.41160	1.09763
19	90	0.93285	0.007871	4.33486	0.87923
20	95	0.97073	0.006144	3.38383	0.68634
21	100	1.00000	0.004701	2.58866	0.52505

PREDICT =The predicted visitation rate for each flow.
MARG =The marginal value per acre/foot of water.
SEMARG =The standard error of the marginal value.
DERIV = First derivative of the flow/visitation model
FLOW = Percentage of actual flows

ACRE FOOT VALUATION OF INSTREAM FLOWS
JULY AND AUG SUBSAMPLE
UPPER SUBBASIN
RESIDENTS
RESERVOIRS

```
OBS    FLOW    PREDICT      DERIV        MARG       SEMARG

  1       0    0.01412    0.000645    0.05084      0.4754
  2       5    0.01882    0.000857    0.06752      0.6313
  3      10    0.02505    0.001135    0.08945      0.8364
  4      15    0.03330    0.001499    0.11811      1.1043
  5      20    0.04417    0.001970    0.15526      1.4517
  6      25    0.05841    0.002575    0.20293      1.8973
  7      30    0.07696    0.003340    0.26323      2.4612
  8      35    0.10091    0.004291    0.33814      3.1616
  9      40    0.13147    0.005443    0.42895      4.0107
 10      45    0.16993    0.006796    0.53556      5.0075
 11      50    0.21748    0.008318    0.65554      6.1292
 12      55    0.27498    0.009937    0.78316      7.3225
 13      60    0.34269    0.011533    0.90894      8.4985
 14      65    0.41997    0.012944    1.02011      9.5379
 15      70    0.50508    0.013991    1.10261     10.3093
 16      75    0.59522    0.014520    1.14433     10.6995
 17      80    0.68683    0.014448    1.13862     10.6460
 18      85    0.77608    0.013785    1.08640     10.1578
 19      90    0.85956    0.012637    0.99589      9.3116
 20      95    0.93468    0.011166    0.88000      8.2280
 21     100    1.00000    0.009551    0.75274      7.0381
```

PREDICT =The predicted visitation rate for each flow.
MARG =The marginal value per acre/foot of water.
SEMARG =The standard error of the marginal value.
DERIV = First derivative of the flow/visitation model
FLOW = Percentage of actual flows

ACRE FOOT VALUATION OF INSTREAM FLOWS
REST OF YEAR SUBSAMPLE
UPPER SUBBASIN
RESIDENTS
RESERVOIRS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.01412	0.000645	0.05084	0.05382
2	5	0.01882	0.000857	0.06752	0.07147
3	10	0.02505	0.001135	0.08945	0.09468
4	15	0.03330	0.001499	0.11811	0.12502
5	20	0.04417	0.001970	0.15526	0.16434
6	25	0.05841	0.002575	0.20293	0.21480
7	30	0.07696	0.003340	0.26323	0.27863
8	35	0.10091	0.004291	0.33814	0.35792
9	40	0.13147	0.005443	0.42895	0.45405
10	45	0.16993	0.006796	0.53556	0.56689
11	50	0.21748	0.008318	0.65554	0.69389
12	55	0.27498	0.009937	0.78316	0.82898
13	60	0.34269	0.011533	0.90894	0.96211
14	65	0.41997	0.012944	1.02011	1.07979
15	70	0.50508	0.013991	1.10261	1.16712
16	75	0.59522	0.014520	1.14433	1.21128
17	80	0.68683	0.014448	1.13862	1.20523
18	85	0.77608	0.013785	1.08640	1.14996
19	90	0.85956	0.012637	0.99589	1.05416
20	95	0.93468	0.011166	0.88000	0.93149
21	100	1.00000	0.009551	0.75274	0.79678

PREDICT =The predicted visitation rate for each flow.
MARG =The marginal value per acre/foot of water.
SEMARG =The standard error of the marginal value.
DERIV = First derivative of the flow/visitation model
FLOW = Percentage of actual flows

```
                 ACRE FOOT VALUATION OF INSTREAM FLOWS
                         JULY AND AUG SUBSAMPLE
                            MIDDLE SUBBASIN
                               RESIDENTS
                                 RIVERS



OBS     FLOW     PREDICT        DERIV          MARG        SEMARG

  1       0      0.02941      0.001559        2.9392      0.80684
  2       5      0.03925      0.002061        3.8862      1.06681
  3      10      0.05221      0.002709        5.1067      1.40185
  4      15      0.06918      0.003530        6.6563      1.82724
  5      20      0.09119      0.004553        8.5850      2.35668
  6      25      0.11938      0.005793       10.9227      2.99841
  7      30      0.15493      0.007244       13.6585      3.74942
  8      35      0.19891      0.008865       16.7142      4.58825
  9      40      0.25203      0.010565       19.9201      5.46831
 10      45      0.31434      0.012202       23.0057      6.31535
 11      50      0.38502      0.013590       25.6225      7.03369
 12      55      0.46215      0.014537       27.4078      7.52379
 13      60      0.54291      0.014893       28.0793      7.70811
 14      65      0.62383      0.014598       27.5234      7.55551
 15      70      0.70145      0.013702       25.8344      7.09186
 16      75      0.77284      0.012348       23.2819      6.39117
 17      80      0.83601      0.010727       20.2252      5.55206
 18      85      0.89001      0.009026       17.0176      4.67153
 19      90      0.93484      0.007393       13.9386      3.82631
 20      95      0.97116      0.005923       11.1675      3.06562
 21     100      1.00000      0.004662        8.7905      2.41309
```

```
PREDICT =The predicted visitation rate for each flow.
MARG =The marginal value per acre/foot of water.
SEMARG =The standard error of the marginal value.
DERIV = First derivative of the flow/visitation model
FLOW = Percentage of actual flows
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ACRE FOOT VALUATION OF INSTREAM FLOWS
REST OF YEAR SUBSAMPLE
MIDDLE SUBBASIN
RESIDENTS
RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.01769	0.000820	0.42222	0.11591
2	5	0.02345	0.001082	0.55709	0.15293
3	10	0.03104	0.001423	0.73275	0.20115
4	15	0.04101	0.001865	0.95985	0.26349
5	20	0.05403	0.002429	1.25059	0.34330
6	25	0.07093	0.003143	1.61803	0.44417
7	30	0.09270	0.004030	2.07455	0.56949
8	35	0.12045	0.005107	2.62918	0.72174
9	40	0.15536	0.006378	3.28349	0.90136
10	45	0.19856	0.007821	4.02614	1.10522
11	50	0.25094	0.009377	4.82711	1.32510
12	55	0.31290	0.010944	5.63384	1.54656
13	60	0.38410	0.012379	6.37242	1.74931
14	65	0.46321	0.013514	6.95690	1.90975
15	70	0.54793	0.014194	7.30704	2.00587
16	75	0.63512	0.014316	7.36962	2.02305
17	80	0.72128	0.013859	7.13474	1.95857
18	85	0.80305	0.012896	6.63896	1.82248
19	90	0.87776	0.011565	5.95383	1.63440
20	95	0.94365	0.010034	5.16544	1.41798
21	100	1.00000	0.008458	4.35436	1.19533

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ACRE FOOT VALUATION OF INSTREAM FLOWS
JULY AND AUG SUBSAMPLE
MIDDLE SUBBASIN
RESIDENTS
RESERVOIRS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.02158	0.001111	0.11251	0.02754
2	5	0.02887	0.001476	0.14953	0.03660
3	10	0.03853	0.001954	0.19786	0.04843
4	15	0.05129	0.002570	0.26028	0.06371
5	20	0.06800	0.003355	0.33976	0.08316
6	25	0.08970	0.004335	0.43909	0.10748
7	30	0.11757	0.005531	0.56015	0.13711
8	35	0.15283	0.006940	0.70288	0.17205
9	40	0.19662	0.008530	0.86392	0.21147
10	45	0.24977	0.010221	1.03522	0.25339
11	50	0.31249	0.011881	1.20331	0.29454
12	55	0.38411	0.013331	1.35018	0.33049
13	60	0.46291	0.014378	1.45620	0.35644
14	65	0.54610	0.014860	1.50497	0.36838
15	70	0.63020	0.014695	1.48832	0.36430
16	75	0.71158	0.013913	1.40910	0.34491
17	80	0.78706	0.012640	1.28014	0.31335
18	85	0.85435	0.011060	1.12013	0.27418
19	90	0.91227	0.009364	0.94841	0.23215
20	95	0.96063	0.007711	0.78094	0.19116
21	100	1.00000	0.006205	0.62843	0.15382

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ACRE FOOT VALUATION OF INSTREAM FLOWS
REST OF YEAR SUBSAMPLE
MIDDLE SUBBASIN
RESIDENTS
RESERVOIRS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.00827	0.000485	0.01793	0.00982
2	5	0.01159	0.000678	0.02506	0.01372
3	10	0.01622	0.000945	0.03495	0.01913
4	15	0.02267	0.001313	0.04856	0.02658
5	20	0.03161	0.001817	0.06719	0.03677
6	25	0.04395	0.002498	0.09238	0.05056
7	30	0.06084	0.003405	0.12592	0.06892
8	35	0.08372	0.004587	0.16966	0.09286
9	40	0.11432	0.006084	0.22503	0.12317
10	45	0.15448	0.007903	0.29232	0.16000
11	50	0.20594	0.009993	0.36962	0.20230
12	55	0.26992	0.012213	0.45170	0.24723
13	60	0.34650	0.014318	0.52955	0.28984
14	65	0.43412	0.015988	0.59135	0.32366
15	70	0.52935	0.016912	0.62550	0.34236
16	75	0.62723	0.016892	0.62478	0.34196
17	80	0.72224	0.015934	0.58933	0.32256
18	85	0.80947	0.014239	0.52664	0.28825
19	90	0.88555	0.012124	0.44841	0.24543
20	95	0.94902	0.009905	0.36636	0.20052
21	100	1.00000	0.007824	0.28939	0.15839

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ACRE FOOT VALUATION OF INSTREAM FLOWS
JULY AND AUG SUBSAMPLE
LOWER SUBBASIN
RESIDENTS
RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.04580	0.001833	1.45282	0.32895
2	5	0.05794	0.002295	1.81837	0.41172
3	10	0.07310	0.002856	2.26305	0.51240
4	15	0.09190	0.003529	2.79670	0.63323
5	20	0.11502	0.004324	3.42624	0.77577
6	25	0.14321	0.005241	4.15298	0.94032
7	30	0.17715	0.006271	4.96928	1.12514
8	35	0.21745	0.007389	5.85492	1.32567
9	40	0.26450	0.008549	6.77413	1.53380
10	45	0.31838	0.009685	7.67461	1.73768
11	50	0.37869	0.010714	8.49032	1.92238
12	55	0.44454	0.011545	9.14883	2.07148
13	60	0.51449	0.012093	9.58297	2.16978
14	65	0.58669	0.012297	9.74426	2.20629
15	70	0.65901	0.012132	9.61382	2.17676
16	75	0.72930	0.011619	9.20695	2.08464
17	80	0.79567	0.010814	8.56941	1.94029
18	85	0.85662	0.009802	7.76702	1.75861
19	90	0.91121	0.008672	6.87224	1.55601
20	95	0.95899	0.007511	5.95227	1.34771
21	100	1.00000	0.006387	5.06104	1.14592

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ACRE FOOT VALUATION OF INSTREAM FLOWS
REST OF YEAR SUBSAMPLE
LOWER SUBBASIN
RESIDENTS
RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.01734	0.000981	0.25011	0.05663
2	5	0.02371	0.001333	0.33989	0.07696
3	10	0.03233	0.001804	0.45992	0.10414
4	15	0.04398	0.002427	0.61875	0.14010
5	20	0.05958	0.003240	0.82597	0.18702
6	25	0.08030	0.004281	1.09121	0.24707
7	30	0.10748	0.005579	1.42201	0.32197
8	35	0.14259	0.007142	1.82034	0.41216
9	40	0.18703	0.008936	2.27771	0.51572
10	45	0.24185	0.010867	2.76995	0.62717
11	50	0.30737	0.012766	3.25402	0.73678
12	55	0.38280	0.014401	3.67068	0.83111
13	60	0.46596	0.015519	3.95565	0.89564
14	65	0.55339	0.015920	4.05800	0.91881
15	70	0.64086	0.015528	3.95807	0.89619
16	75	0.72409	0.014418	3.67506	0.83211
17	80	0.79963	0.012788	3.25963	0.73805
18	85	0.86528	0.010891	2.77600	0.62854
19	90	0.92022	0.008959	2.28356	0.51704
20	95	0.96478	0.007162	1.82558	0.41335
21	100	1.00000	0.005596	1.42646	0.32298

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                  ACRE FOOT VALUATION OF INSTREAM FLOWS
                         JULY AND AUG SUBSAMPLE
                             LOWER SUBBASIN
                               RESIDENTS
                               RESERVOIRS



OBS     FLOW     PREDICT       DERIV         MARG         SEMARG

  1       0      0.03548     0.001569     0.007553     0.002722
  2       5      0.04580     0.002007     0.009661     0.003482
  3      10      0.05896     0.002553     0.012291     0.004429
  4      15      0.07565     0.003226     0.015531     0.005597
  5      20      0.09665     0.004042     0.019457     0.007012
  6      25      0.12282     0.005010     0.024117     0.008692
  7      30      0.15504     0.006128     0.029498     0.010631
  8      35      0.19413     0.007374     0.035498     0.012793
  9      40      0.24072     0.008703     0.041892     0.015098
 10      45      0.29506     0.010037     0.048314     0.017412
 11      50      0.35692     0.011272     0.054260     0.019555
 12      55      0.42536     0.012288     0.059152     0.021318
 13      60      0.49877     0.012969     0.062426     0.022498
 14      65      0.57492     0.013226     0.063665     0.022945
 15      70      0.65125     0.013026     0.062703     0.022598
 16      75      0.72514     0.012396     0.059670     0.021505
 17      80      0.79432     0.011417     0.054955     0.019806
 18      85      0.85708     0.010202     0.049110     0.017699
 19      90      0.91241     0.008875     0.042719     0.015396
 20      95      0.95998     0.007541     0.036298     0.013082
 21     100      1.00000     0.006280     0.030232     0.010895
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ACRE FOOT VALUATION OF INSTREAM FLOWS
REST OF YEAR SUBSAMPLE
LOWER SUBBASIN
RESIDENTS
RESERVOIRS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.01952	0.001000	0.001661	0.001339
2	5	0.02616	0.001333	0.002213	0.001784
3	10	0.03500	0.001769	0.002938	0.002367
4	15	0.04669	0.002336	0.003878	0.003125
5	20	0.06208	0.003062	0.005083	0.004097
6	25	0.08215	0.003977	0.006603	0.005321
7	30	0.10807	0.005104	0.008474	0.006829
8	35	0.14108	0.006451	0.010711	0.008632
9	40	0.18241	0.007998	0.013279	0.010701
10	45	0.23303	0.009681	0.016074	0.012953
11	50	0.29343	0.011384	0.018901	0.015232
12	55	0.36325	0.012939	0.021484	0.017313
13	60	0.44109	0.014150	0.023494	0.018933
14	65	0.52445	0.014835	0.024633	0.019851
15	70	0.60993	0.014882	0.024710	0.019913
16	75	0.69381	0.014282	0.023713	0.019110
17	80	0.77261	0.013135	0.021809	0.017575
18	85	0.84367	0.011616	0.019287	0.015543
19	90	0.90543	0.009922	0.016475	0.013277
20	95	0.95742	0.008228	0.013662	0.011010
21	100	1.00000	0.006657	0.011054	0.008908

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ACRE FOOT VALUATION OF INSTREAM FLOWS
JULY AND AUG SUBSAMPLE
UPPER SUBBASIN
NONRESIDENTS
RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.01643	0.000815	2.4063	0.39324
2	5	0.02202	0.001087	3.2100	0.52460
3	10	0.02947	0.001445	4.2684	0.69756
4	15	0.03935	0.001914	5.6512	0.92354
5	20	0.05240	0.002519	7.4391	1.21574
6	25	0.06951	0.003291	9.7191	1.58835
7	30	0.09175	0.004258	12.5735	2.05483
8	35	0.12034	0.005438	16.0604	2.62468
9	40	0.15657	0.006835	20.1836	3.29851
10	45	0.20164	0.008416	24.8531	4.06162
11	50	0.25644	0.010106	29.8446	4.87736
12	55	0.32126	0.011776	34.7761	5.68329
13	60	0.39549	0.013250	39.1279	6.39449
14	65	0.47738	0.014332	42.3251	6.91699
15	70	0.56409	0.014858	43.8766	7.17054
16	75	0.65202	0.014738	43.5232	7.11278
17	80	0.73736	0.013994	41.3252	6.75357
18	85	0.81672	0.012746	37.6412	6.15152
19	90	0.88765	0.011178	33.0112	5.39487
20	95	0.94883	0.009483	28.0037	4.57651
21	100	1.00000	0.007820	23.0941	3.77415

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              ACRE FOOT VALUATION OF INSTREAM FLOWS
                      REST OF YEAR SUBSAMPLE
                          UPPER SUBBASIN
                           NONRESIDENTS
                              RIVERS



OBS     FLOW     PREDICT        DERIV         MARG      SEMARG

  1        0     0.00720     0.000469       0.4146     0.06775
  2        5     0.01033     0.000670       0.5925     0.09683
  3       10     0.01478     0.000955       0.8447     0.13805
  4       15     0.02112     0.001357       1.2001     0.19613
  5       20     0.03011     0.001918       1.6965     0.27725
  6       25     0.04277     0.002693       2.3815     0.38919
  7       30     0.06045     0.003743       3.3102     0.54097
  8       35     0.08486     0.005132       4.5387     0.74173
  9       40     0.11802     0.006905       6.1075     0.99811
 10       45     0.16208     0.009061       8.0143     1.30973
 11       50     0.21895     0.011505      10.1754     1.66292
 12       55     0.28966     0.014010      12.3909     2.02499
 13       60     0.37362     0.016216      14.3424     2.34391
 14       65     0.46799     0.017702      15.6562     2.55862
 15       70     0.56777     0.018127      16.0326     2.62012
 16       75     0.66665     0.017388      15.3785     2.51323
 17       80     0.75858     0.015664      13.8535     2.26401
 18       85     0.83907     0.013333      11.7925     1.92720
 19       90     0.90596     0.010815       9.5647     1.56312
 20       95     0.95915     0.008434       7.4590     1.21899
 21      100     1.00000     0.006378       5.6410     0.92188
```

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ACRE FOOT VALUATION OF INSTREAM FLOWS
REST OF YEAR SUBSAMPLE
UPPER SUBBASIN
NONRESIDENTS
RIVERS

```
OBS     FLOW     PREDICT        DERIV         MARG        SEMARG

  1        0     0.00720     0.000469       0.4146       0.06775
  2        5     0.01033     0.000670       0.5925       0.09683
  3       10     0.01478     0.000955       0.8447       0.13805
  4       15     0.02112     0.001357       1.2001       0.19613
  5       20     0.03011     0.001918       1.6965       0.27725
  6       25     0.04277     0.002693       2.3815       0.38919
  7       30     0.06045     0.003743       3.3102       0.54097
  8       35     0.08486     0.005132       4.5387       0.74173
  9       40     0.11802     0.006905       6.1075       0.99811
 10       45     0.16208     0.009061       8.0143       1.30973
 11       50     0.21895     0.011505      10.1754       1.66292
 12       55     0.28966     0.014010      12.3909       2.02499
 13       60     0.37362     0.016216      14.3424       2.34391
 14       65     0.46799     0.017702      15.6562       2.55862
 15       70     0.56777     0.018127      16.0326       2.62012
 16       75     0.66665     0.017388      15.3785       2.51323
 17       80     0.75858     0.015664      13.8535       2.26401
 18       85     0.83907     0.013333      11.7925       1.92720
 19       90     0.90596     0.010815       9.5647       1.56312
 20       95     0.95915     0.008434       7.4590       1.21899
 21      100     1.00000     0.006378       5.6410       0.92188
```

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ACRE FOOT VALUATION OF INSTREAM FLOWS
JULY AND AUG SUBSAMPLE
MIDDLE SUBBASIN
NONRESIDENTS
RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.01643	0.000815	0.19641	0.03210
2	5	0.02202	0.001087	0.26202	0.04282
3	10	0.02947	0.001445	0.34840	0.05694
4	15	0.03935	0.001914	0.46127	0.07538
5	20	0.05240	0.002519	0.60721	0.09923
6	25	0.06951	0.003291	0.79332	0.12965
7	30	0.09175	0.004258	1.02631	0.16772
8	35	0.12034	0.005438	1.31092	0.21424
9	40	0.15657	0.006835	1.64747	0.26924
10	45	0.20164	0.008416	2.02862	0.33153
11	50	0.25644	0.010106	2.43604	0.39811
12	55	0.32126	0.011776	2.83857	0.46389
13	60	0.39549	0.013250	3.19379	0.52195
14	65	0.47738	0.014332	3.45476	0.56459
15	70	0.56409	0.014858	3.58139	0.58529
16	75	0.65202	0.014738	3.55255	0.58058
17	80	0.73736	0.013994	3.37313	0.55126
18	85	0.81672	0.012746	3.07244	0.50211
19	90	0.88765	0.011178	2.69452	0.44035
20	95	0.94883	0.009483	2.28578	0.37355
21	100	1.00000	0.007820	1.88504	0.30806

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FLOW = Percentage of actual flows

ACRE FOOT VALUATION OF INSTREAM FLOWS
REST OF YEAR SUBSAMPLE
MIDDLE SUBBASIN
NONRESIDENTS
RIVERS

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OBS     FLOW     PREDICT       DERIV          MARG        SEMARG

  1        0     0.00720     0.000469      0.03085      0.00504
  2        5     0.01033     0.000670      0.04409      0.00721
  3       10     0.01478     0.000955      0.06286      0.01027
  4       15     0.02112     0.001357      0.08931      0.01460
  5       20     0.03011     0.001918      0.12625      0.02063
  6       25     0.04277     0.002693      0.17722      0.02896
  7       30     0.06045     0.003743      0.24634      0.04026
  8       35     0.08486     0.005132      0.33775      0.05520
  9       40     0.11802     0.006905      0.45450      0.07428
 10       45     0.16208     0.009061      0.59639      0.09747
 11       50     0.21895     0.011505      0.75722      0.12375
 12       55     0.28966     0.014010      0.92209      0.15069
 13       60     0.37362     0.016216      1.06732      0.17443
 14       65     0.46799     0.017702      1.16509      0.19040
 15       70     0.56777     0.018127      1.19309      0.19498
 16       75     0.66665     0.017388      1.14442      0.18703
 17       80     0.75858     0.015664      1.03093      0.16848
 18       85     0.83907     0.013333      0.87756      0.14342
 19       90     0.90596     0.010815      0.71177      0.11632
 20       95     0.95915     0.008434      0.55507      0.09071
 21      100     1.00000     0.006378      0.41978      0.06860
```

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DERIV = First derivative of the flow/visitation model
FLOW = Percentage of actual flows

ACRE FOOT VALUATION OF INSTREAM FLOWS
JULY AND AUG SUBSAMPLE
LOWER SUBBASIN
NONRESIDENTS
RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.01643	0.000815	0.07894	0.01290
2	5	0.02202	0.001087	0.10530	0.01721
3	10	0.02947	0.001445	0.14002	0.02288
4	15	0.03935	0.001914	0.18538	0.03030
5	20	0.05240	0.002519	0.24403	0.03988
6	25	0.06951	0.003291	0.31883	0.05210
7	30	0.09175	0.004258	0.41246	0.06741
8	35	0.12034	0.005438	0.52685	0.08610
9	40	0.15657	0.006835	0.66211	0.10820
10	45	0.20164	0.008416	0.81529	0.13324
11	50	0.25644	0.010106	0.97903	0.16000
12	55	0.32126	0.011776	1.14080	0.18644
13	60	0.39549	0.013250	1.28356	0.20977
14	65	0.47738	0.014332	1.38844	0.22691
15	70	0.56409	0.014858	1.43933	0.23522
16	75	0.65202	0.014738	1.42774	0.23333
17	80	0.73736	0.013994	1.35564	0.22155
18	85	0.81672	0.012746	1.23479	0.20180
19	90	0.88765	0.011178	1.08291	0.17697
20	95	0.94883	0.009483	0.91864	0.15013
21	100	1.00000	0.007820	0.75758	0.12381

PREDICT =The predicted visitation rate for each flow.
MARG =The marginal value per acre/foot of water.
SEMARG =The standard error of the marginal value.
DERIV = First derivative of the flow/visitation model
FLOW = Percentage of actual flows

ACRE FOOT VALUATION OF INSTREAM FLOWS
REST OF YEAR SUBSAMPLE
LOWER SUBBASIN
NONRESIDENTS
RIVERS

OBS	FLOW	PREDICT	DERIV	MARG	SEMARG
1	0	0.00720	0.000469	0.01461	0.002387
2	5	0.01033	0.000670	0.02088	0.003412
3	10	0.01478	0.000955	0.02976	0.004864
4	15	0.02112	0.001357	0.04228	0.006910
5	20	0.03011	0.001918	0.05977	0.009768
6	25	0.04277	0.002693	0.08391	0.013712
7	30	0.06045	0.003743	0.11663	0.019060
8	35	0.08486	0.005132	0.15991	0.026133
9	40	0.11802	0.006905	0.21518	0.035166
10	45	0.16208	0.009061	0.28236	0.046145
11	50	0.21895	0.011505	0.35851	0.058589
12	55	0.28966	0.014010	0.43656	0.071346
13	60	0.37362	0.016216	0.50532	0.082582
14	65	0.46799	0.017702	0.55161	0.090147
15	70	0.56777	0.018127	0.56487	0.092314
16	75	0.66665	0.017388	0.54182	0.088548
17	80	0.75858	0.015664	0.48809	0.079767
18	85	0.83907	0.013333	0.41548	0.067900
19	90	0.90596	0.010815	0.33699	0.055073
20	95	0.95915	0.008434	0.26280	0.042948
21	100	1.00000	0.006378	0.19875	0.032480

PREDICT =The predicted visitation rate for each flow.
MARG =The marginal value per acre/foot of water.
SEMARG =The standard error of the marginal value.
DERIV = First derivative of the flow/visitation model
FLOW = Percentage of actual flows